SEPTEMBER, 1958

# WORLD OIL

**Some important lessons in air and gas drilling** page 83

**Proper pumping speeds cut deep lifting costs** page 89

**Shallow pays are making Delaware basin attractive** page 94

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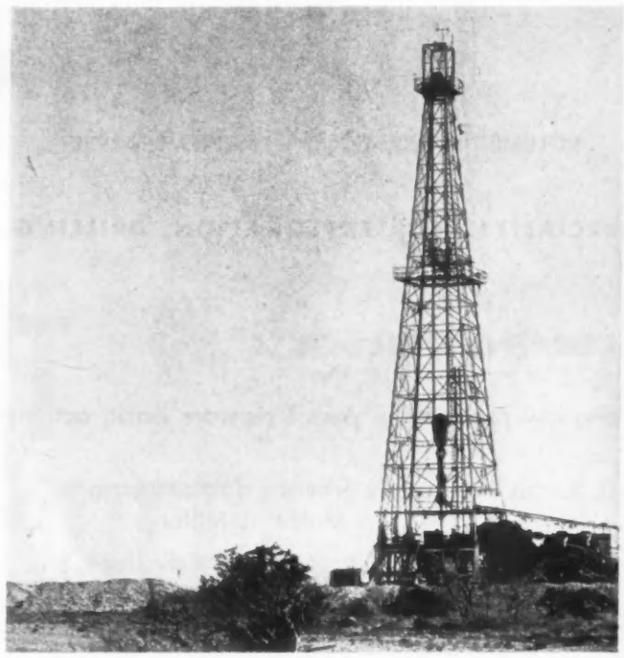
# a Quick Look at WORLD OIL this month

BUSY OIL MEN: To help you put first things first, scan these time-saving digests on this and the following pages, checking ☐ those you want to read first.



### How to improve drilling practices?

☐ Several operators in Terrell County, Texas, are cutting their drilling costs in half through the use of air and gas drilling. This fluid medium is very adaptable in this area and its astounding success has buoyed activity. For more information on results being obtained, turn to **Page 83, Air and Gas Drilling as Cost-Cutters** ..... **Jack F. Earl**

☐ **U. S. oil prospects** have been materially brightened by a substantial upturn in consumption rates in recent months. Further reductions in crude oil stocks further brighten the outlook. However, there is danger that gasoline output and imports of refined products are increasing far too rapidly. **See Page 25. Strong Upturn in a Gasoline Demand**..... **Warren L. Baker**

☐ **Selecting a proper pumping speed for deep wells** is of primary importance. Non-synchronous pumping speeds can reduce operational difficulties and increase profits. Here is an easily understood method for selecting the right pumping speeds in wells with three- and four-way tapered rod strings. **See Page 89. Proper Pumping Speeds for Deep Wells**.. **T. H. Fraser**

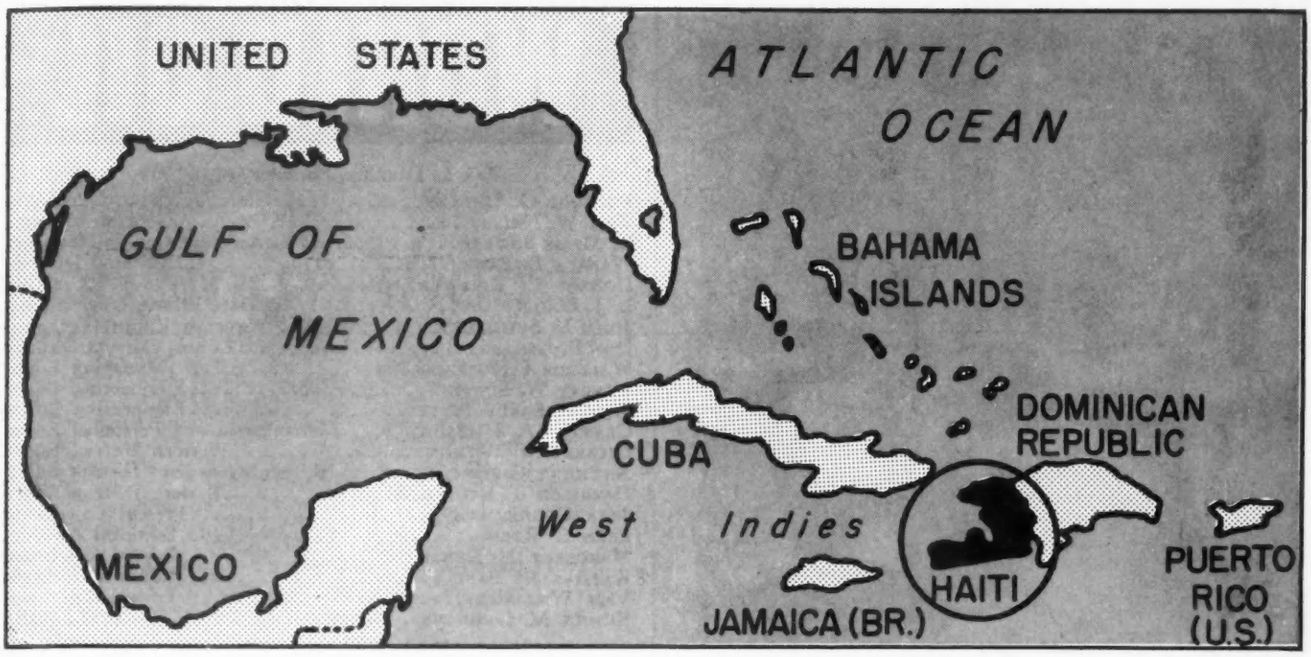
☐ **The Delaware Basin is in the midst of its most active era,** due principally to the sudden upswing in wildcat drilling for the shallow and moderate depth Delaware sand production. For a detailed staff report on the growth of Delaware sand activity, the most effective exploration methods being used, plus a highly informative discussion of the drilling and completion problems operators are facing in the shallower areas of the Basin, read **Shallow Production Spurs Delaware Basin Activity**..... **Page 94**

☐ **Here's a case history of the successful gas injection program** in the Williams field of West Texas showing how the initial calculations of the predicted behavior of the reservoir were fairly close to the actual performance. This gas injection was predicted by the Tarner method of material balance. Turn to **Page 97. How Predicted and Actual Performance Compared in a West Texas Reservoir**..... **E. E. Runyan**

☐ **Many great opportunities still exist in the Mid-Continent,** a geological province where practically every type of structure or trap that produces oil and gas can be found and studied. See **Page 101. The Mid-Continent—a Land of Geological Opportunity** ..... **Dr. A. I. Levorsen**

## Practical operating

WORLD OIL, published every month except semi-monthly in February and August. Entered as THE OIL WEEKLY as second class mail matter December 23, 1916, at post office at Houston, Texas, under the act of March 3, 1879.




## *Republic of Haiti may join the ranks of oil-producing countries*

☐ Conditions are favorable in the Republic of Haiti, which occupies the western third of the Ile d'-Haiti. Both major and independent operators are attracted by a friendly government and the prospects of oil in at least four distinct basins, with marine sedimentary sections aggregating about 26,000 feet of thickness. Of four wells drilled on mainland of Haiti during 1944-47, three had live oil shows in Tertiary beds, and the fourth encountered a non-commercial flow of natural gas. Commonwealth Oil Company has been actively seeking oil on the mainland since early this year. Turn to **Page 142** for a complete review of Haiti. **Haiti Has Good Oil and Gas Possibilities**.....
**A. H. Wadsworth, Jr.**

---

☐ **Diesel-mechanical power is now being designed into cantilever type drilling barges.** Previously, only diesel-electric has been used in this application due to space limitations. For more about this innovation, read **Cantilever Drilling Barge Has Diesel-Mechanical Power** .....**Page 105**

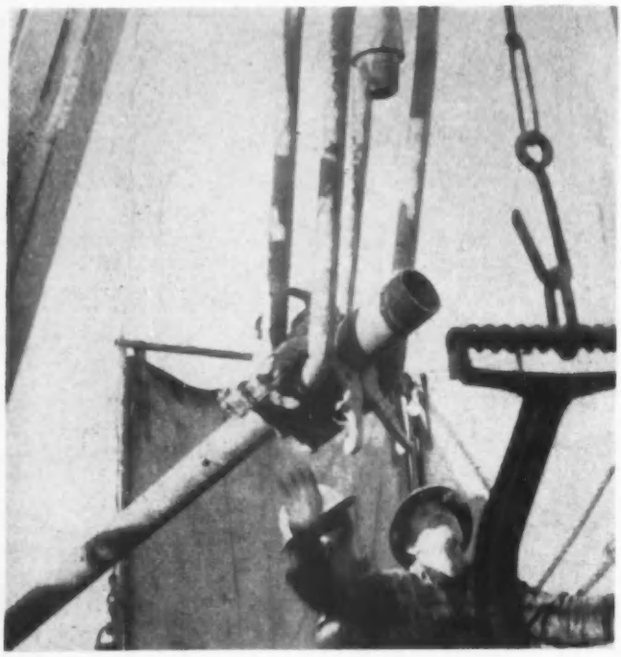
☐ **A "quiz program" was held in Independence, Kansas.** The prize was not the fantastic sums doled out on TV counterparts, but a valuable exchange of ideas on water-flood practices in the Mid-Continent area. For the questions asked, the answers, and a look at the panel of experts, see **Experts Answer Questions on Water-flooding**.....**Page 106**

☐ **Modern air and gas drilling methods** have largely overcome the problem of extremely hard Appalachian rocks in western Pennsylvania and northeastern West Virginia. They also have essentially replaced cable tools to effect rapid development of a lucrative structural trend spanning more than 200 miles. For the full story of this challenging region, read **Deep Gas Play Active in Pennsylvania and West Virginia** .....**Page 113**

☐ **Check this straightforward method** of estimating ultimate recovery from water-drive reservoirs. Reasonably accurate predictions can be made after only short periods of producing history. It's the third in a series of helpful articles on reservoir engineering. **Page 116. Ultimate Recovery from Water-Drive Reservoirs**
**Frank W. Cole**

☐ **Gas injectivity profile logging** as a means of locating points of gas entry into gas input well formations is providing good results for The Texas Company. An excellent description of the methods used and resulting factual data are presented in the article beginning on **Page 117. Gas Injectivity Profile Logging Is Successful**.....**Richard H. Widmyer**

***hints on page 44 of this issue***



## *Mousehole connection, no mousehole*

☐ One company is saving rig time by making mousehole connections without a mousehole. This new technique eliminates the necessity of setting the kelly back in the rathole each time a connection is made. For more information on this and other time and money-saving How to Do It ideas, read this month's **Practical Operating Hints** starting on **Page 44.**

☐ **Severe demands are placed** on pumping equipment by the present-day drilling practices for higher mud pressures and volumes. One way the contractor can realize pumping improvements is by designing and applying the right equipment to his mud pump. A suction dampener, either shopmade or commercial, can help smooth pump operation, reduce pressure requirements and prevent knock. See **Page 122. Know Your Mud Pump (Part 3)** . . . . . **Samuel L. Collier and Carl Aalund**

☐ **U. S. demand for natural gas will continue to increase sharply.** The gas is a highly desirable and economical fuel. To meet the demand, increasingly large quantities of gas will need to be discovered, developed and produced. U. S. reserves can and will be expanded materially, making possible continued steeping up of production and consumption for over a decade and possibly for several decades. See **Page 136. U. S. Can Long Supply Growing Gas Demand** **Ralph L. Miller**

☐ **Earnings of the oil industry,** as well as business in general, promise to improve henceforth, after having declined for a year. It is unlikely that oil companies will earn as much in the third quarter of 1958 as in the like period of 1957. But any decrease from last year should be much smaller than the 38 percent decline registered in the second quarter or the 33 percent drop of the first quarter. The industry's profits had been down about 13 percent in the fourth quarter of 1957 and off about 7 percent in the third quarter. See **Page 151. Earnings Promise to Improve After Declining for a Year** . . . . . **L. J. Logan**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# Looking Ahead

***Earnings to Improve in Second Half . . .*** U. S. oil company earnings are expected to drop 30 percent in '58, but year-to-year dip in second half may average only 10 percent down. (See Page 151.)

**Earnings of 41 oil companies** were off 33 percent in first quarter, 38 percent in second quarter.

***Production Picture Brightens . . .*** BuMines predicts U. S. crude production will increase 1.7 percent in September to 6.9 million barrels per day, compared with 6.8 million in August.

**Proration schedules are easing:** Louisiana allowables will increase about 21,000 barrels daily in September. Texas schedule will show third increase in as many months, up to 12 days in September, compared with last month's 11 days and 8 days in April, May and June.

***Industry Costs Rise Again . . .*** Recent three percent increase in steel prices will cost the oil industry about $50 million annually. If drilling and production pick up as expected, equipment purchases must increase—costs will bite just a little deeper into company profits. Industry may be forced to widen cost-price margin by increasing crude prices early in '59.

***Green Light for Alaska Leasing . . .*** Acreage in Alaska's Gubik gas field in the far north are up for leasing, according to Interior Secretary Fred Seaton. Leasing had been suspended pending completion of enabling legislation in Congress. Gubik field is considered a major gas reserve by U. S. Geological Survey men familiar with Alaska.

**Gubik-Fairbanks pipe line project** is expected to be revived when field is developed. Also, annual rentals on Federal oil leases in Alaska are being raised from 25 to 50 cents per acre, to accelerate exploratory efforts and to discourage promoters from tying up leases for long periods.

***Quick Look at Washington . . .*** Wyoming's Democratic Senator O'Mahoney is strongly opposed to plan that would have representatives of private companies carry out measures to cope with oil shortages that may arise out of another Middle East crisis—says government should do the job . . . **Pressure is mounting to have Eisenhower cut voluntary imports** of crude back to 1954 levels—complete revamping of the import program may be in the offing, including restrictions of products under new Trade Act . . . **After talking one gas bill to death,** forces are being gathered to introduce another in next session of Congress—in the meantime, there is considerable confusion in FPC over independent gas producers whose gas goes into interstate pipe lines . . . **Eisenhower has been requested to relax U. S.-Canada oil import policy** on basis that voluntary limitation of imports jeopardizes national security, threatens orderly development of markets and causes friction between U. S. and Canada.

**Continued on next page . . .**

## *Looking ahead . . .*

***New Activity in Denver Julesburg . . .*** Morgan County is fast becoming hottest area in Colorado portion of Denver Julesburg Basin (See July WORLD OIL, Page 60). Latest wildcat to prove successful is located 2½ miles southwest of West Bijou field and three miles southeast of Orchard field. Bijou field was opened earlier this year with gas discovery that flowed more than 13 million cubic feet per day. North Bijou field was opened with discovery which made more than 900 barrels of oil per day.

***Drilling Outlook Brightens . . .*** For second consecutive month, August well completions in the U.S. exceeded 4,000, compared with April low of 3,553. Prospects indicate continuation of present rate, making it increasingly probable that about 48,000 wells will be drilled during '58 (See Page 28).

**Total U.S. rigs operating at July's end:** 4,098, an increase of 21 over previous month, 238 more than low of 3,860 rigs in April. Totals are expected to stay near July levels for remainder of '58.

***Status of West Texas "Record Holders" . . .*** Phillips University EE1 in Pecos County, world's deepest well at 24,340 feet, has been waiting on specially manufactured 3½-inch drill pipe. Expected delivery date was September 1. Projected TD: Approximately 25,000 feet.

**Twenty miles southwest of EE1,** Phillips and Sinclair A-1 Montgomery was pulling tubing and squeezing open hole at 23,000-23,400 feet in late August. Test at 10,400 feet recovered 10 barrels of salt water and good show of gas.

***Major Oil Concession for Ecuador? . . .*** Unrest in the Middle East is spurring development of South American oil resources. Universal Mineral Resources President Lester Renard says interest in Ecuador's oil concessions has trebled over night. Negotiations involving millions of acres may soon be finaled, with major U.S. producer signing the contract.

**Last year,** Ecuador was the only South American country to show a drop in production —from 3.4 million barrels annually in '56 to 3.1 million in '57.

***Argentina to Step Up Drilling Activity . . .*** Pan American International Oil Company is setting up operations to carry out exploratory drilling contract signed with Argentina last month. According to 15-year agreement, with five-year option, Pan Am will carry out fast moving program in southern Argentina and Patagonia.

**During first year,** 50 wells will be drilled in Cerro Dragon and Sarmiento areas. If initial drilling proves out, 10 rigs will be used to drill 100 more wells during second year, and 40-mile pipe line will be built from Cerro Dragon to coast of Jan Jorge Gulf.

***Caution Lights Are Up . . .*** Continental Oil President L. F. McCollum warns that oil industry may be headed for serious inventory problems unless product stocks, refinery runs and refinery yields are watched closely during next few months. Reasons: On August 1, product stocks were down less than 1 percent, while crude stocks were down 12 percent from year ago levels—**In Mid-Continent** area, demand for products has been running 3 percent under 1957, yet gasoline stocks are 10 percent higher—**On Pacific Coast,** crude and product stocks are about 24 percent over '57 levels.

# How High Can Prices Go?

**There is one certainty** you can count on in these uncertain times: If something isn't done to stop it, the U.S. inflationary spiral will reach the moon well ahead of our rockets.

Inflation exploded another booster rocket early last month when the steel industry raised its prices 3 percent because it couldn't absorb a 26 cents-per-hour wage increase. In turn, suppliers were forced to pass the higher prices on to oil industry equipment purchasers.

The U.S. oil industry is not in any position to absorb increased wage and materials costs, although this benevolent practice has almost become a habit. Within the past five years (June, 1953-June, 1958), the U.S. Bureau of Labor statistics reports that oil field machinery prices increased 23.4 percent, oil well alloy casing prices increased 48.5 percent and oil well carbon casing prices increased 36.1 percent. Between June, 1953 and December, 1957 average oil production wages jumped 24.5 percent.

*Yet, the price of crude oil increased only 10.7 percent between June, 1953 and June, 1958.*

**This remarkable record** of holding back prices in the face of rising wage and materials costs is a great tribute to the U.S. oil industry. But, you can't put tributes in the bank. Oil company mid-year reports show a substantial decrease in profits. The margin between cost and the price of crude and refined products already is too narrow to permit the industry to absorb another increase in operating costs.

This puts the industry squarely between the devil and the deep blue sea. Two perennial barriers stand firmly in the way of the sorely needed oil price increase:

- The depressing influence on markets of large quantities of cheaper foreign oil, which has not only driven U.S. oil almost completely out of international markets but also has weakened domestic price structures. Spiraling costs already have priced U.S. oil out of competition. Any additional increase in U.S. oil prices would further reduce its ability to compete with foreign oil. (This also is true of many other U.S. industries.)
- An oil price increase would invite another anti-trust investigation and add fuel to business critics' efforts for federal price control. Wisconsin's Republican Senator Wiley has asked why price controls should not be clamped on steel to protect the public against inflation. Tennessee's Democratic Senator Kefauver has said he will urge an investigation of industry pricing before Congress adjourns.

It will take raw courage for the oil industry to raise prices in the face of such obstacles. While higher prices would further reduce the ability of U.S. oil to compete with foreign oil, this may well be the only alternative.

Unless some price adjustment is made to compensate for higher costs, the U.S. oil industry faces serious financial troubles. It will not have sufficient funds to drill enough wells, and to install adequate new producing, refining and pipe line facilities to maintain the industry's ability to supply the nation's needs.

An assured, ample supply of oil is vital to the economic, industrial and military welfare of the U.S. This supply must be accessible under the most imaginable adverse conditions, which means it must be in North America. To maintain an adequate, accessible supply, the U.S. oil industry must have healthy financial conditions.

Something must be done to stop inflationary price increases in the U.S. It cannot be accomplished as long as higher wages increase costs. Labor and management should set about to take the bull by the horns. Both groups would have to agree to hold the line.

If industry doesn't do something along these lines, it is conceivable that government price controls may not be too far away. This would be pure socialism, and would stop the country's progress dead in its tracks.

Something must be done to bring U.S. prices out of orbit and back to earth. They can't keep going up forever.

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By WARREN L. BAKER

# Strong upturn in demand brightens outlook

**Industry must exercise caution to keep rising refinery output of gasoline and increased product imports from destroying improving prospects.**

**A surprisingly strong upturn** in demand for U.S. petroleum products during the past two months has further brightened the industry's outlook.

Estimated total demand for U.S. oil rose sharply in July to slightly over 8.9 million barrels per day, approximately 300,000 barrels above June and 260,000 barrels over July, 1957. June is the only other month this year in which demand has exceeded year ago levels.

This upturn in demand, coupled with increasing signs that general business will show considerable recovery in coming months, presages demand for U.S. oil in the last half of 1958 may exceed earlier expectations.

Obviously, this would have a highly beneficial influence on the industry's economic prospects.

**The crude oil picture** is particularly bright. Additional impressive inventory reductions have occurred in recent weeks. Despite increased producing rates, further drafts on crude oil stocks have taken place since July 1.

On August 9, total U.S. crude oil inventories totaled only 249¾ million barrels, which is 36 million barrels less than at the end of February and a similar amount below year ago levels.

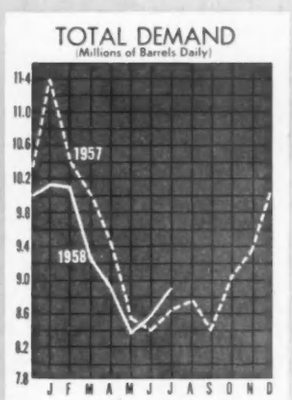
This has reduced crude stocks to the minimum quantity required for operating purposes. In the future, enough crude must be produced currently to fulfill existing needs and to rebuild crude stocks to some extent.

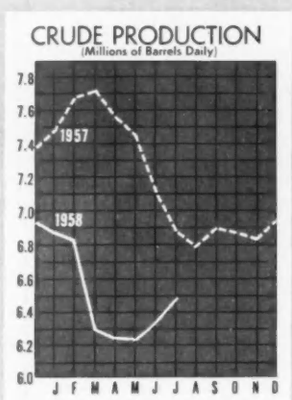
Increased production in August and September is expected to do little more than arrest stock reductions.

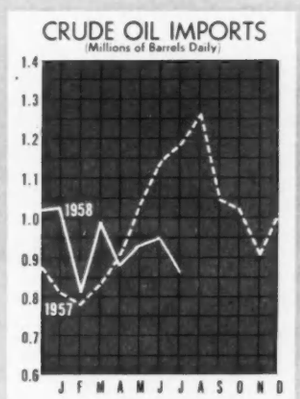
**Some dark clouds loom** on the horizon despite the generally brighter outlook. Chief danger rests in the possibility that gasoline output may be increased too rapidly. This would undo all the good accomplished by the painful inventory correction during the past six months.

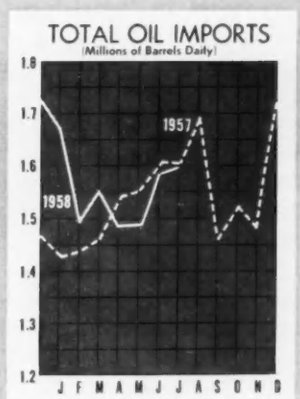
Product inventories are not properly balanced, and recent refining rates have created additional imbal-

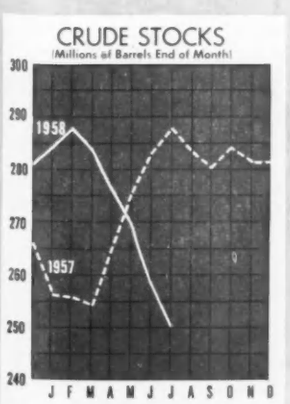
## Petroleum Trends...

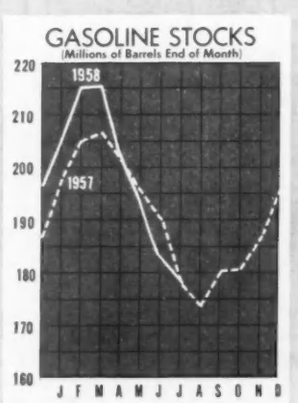


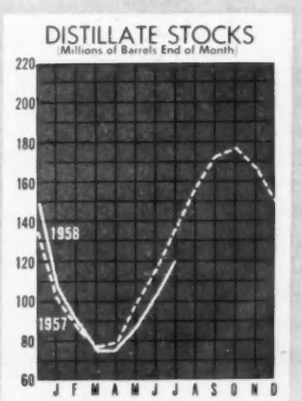



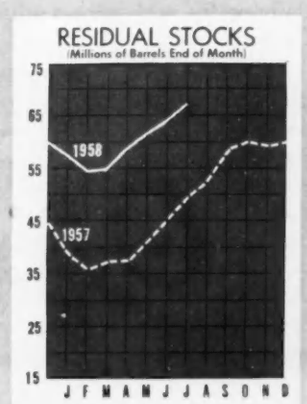



ance. Total inventories of gasoline on August 15 were 4⅓ million barrels higher than a year ago, whereas they had been identical with a year ago at the close of May. Significantly, stocks outside of the West Coast now are more than 5 million barrels higher than a year ago.

This is the result of unreasonable gains in output of gasoline during recent months. The industry must exercise caution in advancing refinery runs if it is to avoid burdensome gasoline stocks by the end of the motor fuel consuming season.

There also is a current imbalance between gasoline and distillate inventories. Stocks of distillate in mid-August were 18 million barrels lower than a year ago. This presages the possibility of insufficient distillate stocks if there is an abnormally cold, early winter.

The existence of surplus gasoline and possible shortage of distillate inventories suggests that refinery yields of gasoline should be reduced and distillate yields advanced. A one percent increase in refinery distillate yields and a similar reduction in gasoline yields would add about 7 million barrels to distillate stocks by November 1 and accomplish a corresponding reduction in gasoline production. Both are desirable.

**The need to restrict product imports** and to revamp the crude oil program has become increasingly evident during recent months.

Product imports have been growing at rates which completely offset reductions made in crude imports under the government's voluntary import curb.

The need for broadening of import controls also is demonstrated by the large number of new applicants for crude oil imports quotas. There are 82 requests for quota assignments totaling 666,000 barrels of crude oil daily on file with import administrator Carson.

These developments presage that the present voluntary program must be overhauled. Product imports are just as damaging to the U.S. oil economy as crude imports. Obviously, curbing of crude imports does not help the domestic industry if imports of products increase. It is equally obvious that granting of new additional crude quotas would nullify reductions made to date.

## U. S. Monthly Oil Trends

(THOUSANDS OF BARRELS DAILY)

| | JULY | | | June | JANUARY-JULY | | |
|---|---|---|---|---|---|---|---|
| | 1958 | 1957 | % Diff. | 1958 | 1958 | 1957 | % Diff. |
| U.S. Crude Oil Production | 6,504 | 6,873 | — 5.4 | 6,335 | 6,469 | 7,403 | —12.6 |
| U.S. Nat. Gas Liquid Prod. | 780 | 734 | + 6.3 | 750 | 781 | 806 | — 3.1 |
| U.S. Imports | 1,597 | 1,601 | — 0.3 | 1,580 | 1,639 | 1,519 | + 7.9 |
| East Coast Crude Imports | 685 | 840 | —18.5 | 700 | 752 | 711 | + 5.8 |
| Total Crude Imports | 852 | 1,180 | —27.8 | 950 | 924 | 958 | — 3.6 |
| Total Refined Products | 745 | 421 | +76.9 | 630 | 714 | 560 | +27.5 |
| Total New Supply | 8,826 | 9,208 | — 4.2 | 8,666 | 8,881 | 9,727 | — 8.7 |
| Stock Changes All Oils (Daily) | —99 | +544 | ..... | +70 | —351 | +183 | ..... |
| Total Demand All U.S. Oils | 8,925 | 8,664 | + 3.0 | 8,596 | 9,232 | 9,544 | — 3.3 |
| Gasoline Demand | 4,275 | 4,285 | — 0.2 | 4,182 | 3,884 | 3,938 | — 1.4 |
| Distillate Fuel Demand | 1,210 | 1,095 | +10.5 | 1,153 | 1,848 | 1,874 | — 1.4 |
| Residual Fuel Demand | 1,300 | 1,334 | — 2.6 | 1,232 | 1,510 | 1,664 | — 9.3 |
| Domestic Demand, All Oils | 8,675 | 8,271 | + 4.5 | 8,346 | 8,970 | 8,833 | + 1.6 |
| Export Demand, All Oils | 250 | 392 | —36.2 | 250 | 261 | 711 | —63.3 |
| Crude Runs U.S. Refineries | 7,564 | 7,852 | — 3.7 | 7,578 | 7,312 | 7,980 | — 8.4 |
| Domestic Crude Runs | 6,658 | 6,696 | — 0.6 | 6,601 | 6,550 | 7,042 | — 7.0 |
| Foreign Crude Runs | 906 | 1,156 | —21.6 | 977 | 921 | 938 | — 1.8 |

| | TOTAL U.S. STOCKS Millions of Barrels End of Month | | | | STOCKS EAST OF CALIFORNIA Millions of Barrels End of Month | | | |
|---|---|---|---|---|---|---|---|---|
| | July | | | June | July | | | June |
| | 1958 | 1957 | % Diff. | 1958 | 1958 | 1957 | % Diff. | 1958 |
| Crude Oil | 249.9 | 288.2 | —13.3 | 257.3 | 207.5 | 252.3 | —17.8 | 212.4 |
| Gasoline | 178.7 | 177.9 | + 0.4 | 184.7 | 153.6 | 152.0 | + 1.1 | 158.7 |
| Distillate Fuel Oil | 120.4 | 138.4 | —13.0 | 105.2 | 107.1 | 123.6 | —13.4 | 92.1 |
| Residual Fuel Oil | 66.9 | 49.6 | +34.9 | 64.3 | 34.3 | 32.7 | + 4.9 | 32.1 |
| Kerosine | 25.9 | 31.7 | —18.3 | 24.2 | 25.5 | 31.4 | —18.8 | 23.8 |

**Source:** Except for latest two months, all data from U.S. Bureau of Mines. Data for last two months from American Petroleum Institute weekly reports and U.S. Bureau of Mines weekly crude stock report, except U.S. Natural Gas Liquids Production and Demand figures which are estimated by World Oil.

## U. S. Crude Production By States

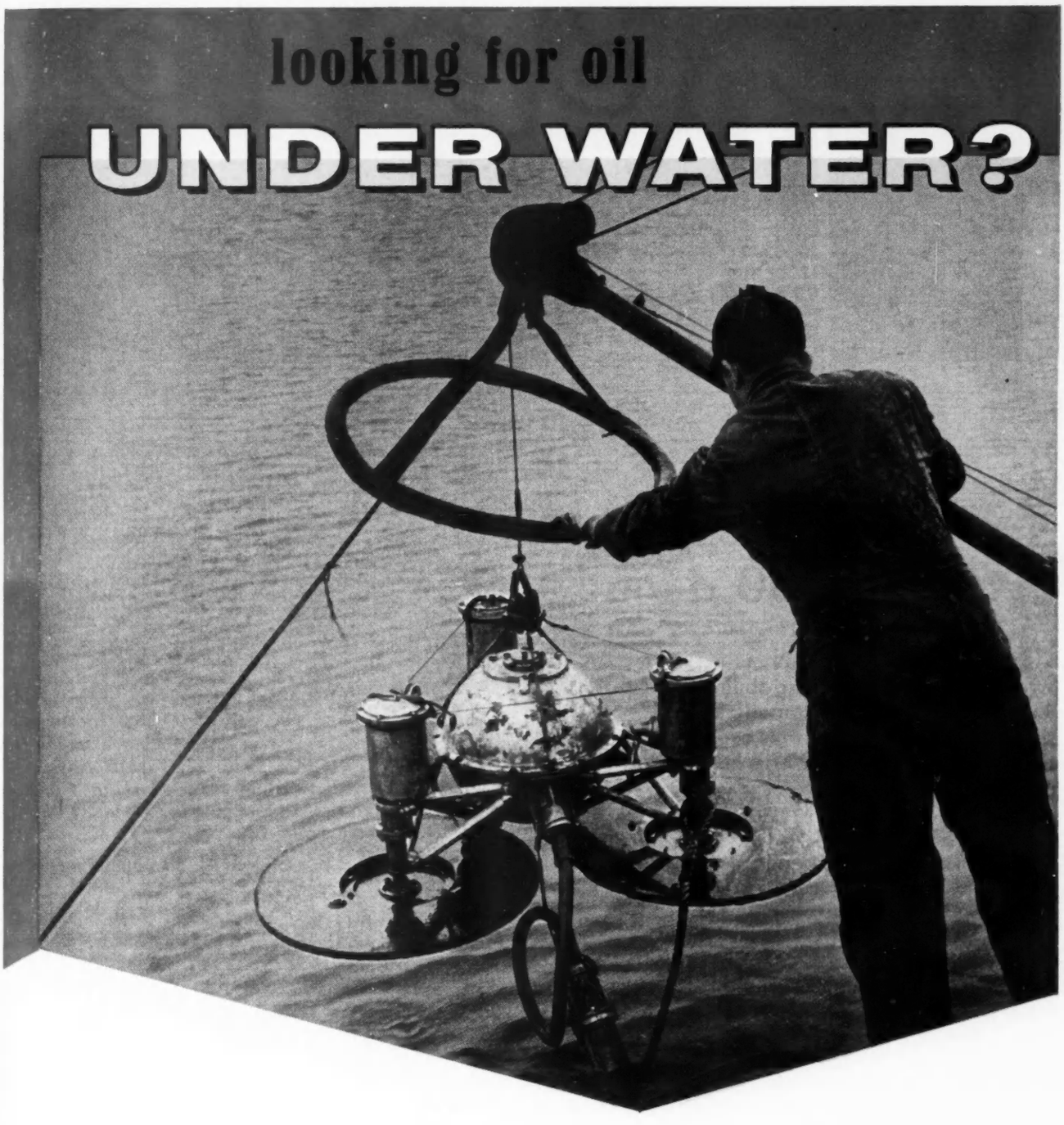
(THOUSANDS OF BARRELS)

| STATE or DISTRICT | DAILY AVERAGE PRODUCTION July 1958 | July 1957 | % Diff. | June, 1958 | TOTAL PRODUCTION January-July 1958 | January-July 1957 | % Diff. |
|---|---|---|---|---|---|---|---|
| Alabama | 17.7 | 16.6 | + 6.6 | 15.9 | 3,412 | 3,036 | + 12.4 |
| Arkansas | 74.7 | 81.3 | — 8.1 | 75.4 | 16,598 | 17,912 | — 7.3 |
| California | 854.9 | 929.4 | — 8.0 | 850.1 | 184,333 | 197,425 | — 6.6 |
| Colorado | 133.8 | 149.8 | — 10.7 | 132.1 | 28,687 | 32,660 | — 12.2 |
| Florida | 1.2 | 1.2 | ..... | 1.3 | 265 | 266 | — 0.4 |
| Illinois | 225.4 | 182.6 | + 23.4 | 227.2 | 47,517 | 43,925 | + 8.2 |
| Indiana | 30.9 | 32.7 | — 5.5 | 31.5 | 6,726 | 7,569 | — 11.1 |
| Kansas | 318.7 | 335.1 | — 4.9 | 322.1 | 67,220 | 70,435 | — 4.6 |
| Kentucky | 42.1 | 47.6 | — 11.6 | 43.3 | 9,132 | 9,855 | — 7.3 |
| Louisiana | 814.8 | 856.3 | — 4.9 | 813.4 | 174,278 | 200,406 | — 13.0 |
| North Louisiana | 106.2 | 131.4 | — 19.2 | 112.6 | 24,033 | 28,596 | — 16.0 |
| South Louisiana | 708.6 | 724.9 | — 2.3 | 700.8 | 150,245 | 171,810 | — 12.6 |
| Michigan | 24.5 | 28.9 | — 15.2 | 25.0 | 5,357 | 6,021 | — 11.0 |
| Mississippi | 98.9 | 102.2 | — 3.2 | 97.8 | 20,672 | 23,659 | — 12.6 |
| Missouri-Tennessee-South Dakota | 0.3 | 0.3 | ..... | 0.3 | 72 | 53 | + 35.8 |
| Montana | 77.5 | 76.8 | + 0.9 | 78.4 | 16,227 | 15,461 | + 5.0 |
| Nebraska | 55.5 | 52.6 | + 5.5 | 54.2 | 11,262 | 10,656 | + 5.7 |
| Nevada | 0.1 | 0.1 | ..... | 0.1 | 18 | 19 | — 5.3 |
| New Mexico | 280.3 | 256.6 | + 9.2 | 283.4 | 56,473 | 55,247 | + 2.2 |
| Southeast New Mexico | 249.2 | 250.6 | — 0.6 | 248.4 | 52,333 | 53,979 | — 3.1 |
| Northwest New Mexico | 31.2 | 5.6 | +457.1 | 35.0 | 4,140 | 1,268 | +226.5 |
| New York | 4.5 | 7.7 | — 41.6 | 5.8 | 1,295 | 1,583 | — 18.2 |
| North Dakota | 37.9 | 40.2 | — 5.7 | 38.4 | 8,299 | 8,405 | — 1.3 |
| Ohio | 16.7 | 16.4 | + 1.8 | 17.5 | 3,645 | 2,996 | + 21.7 |
| Oklahoma | 555.6 | 557.8 | — 0.4 | 534.3 | 116,447 | 128,185 | — 9.2 |
| Pennsylvania | 18.2 | 23.2 | — 21.6 | 17.9 | 3,975 | 4,896 | — 18.8 |
| Texas | 2,401.2 | 2,780.7 | — 13.7 | 2,278.7 | 513,917 | 663,817 | — 22.6 |
| Dist. 1: South Central | 43.5 | 52.5 | — 17.5 | 45.8 | 9,672 | 11,812 | — 18.1 |
| Dist. 2: Middle Gulf | 103.9 | 134.6 | — 22.8 | 98.7 | 22,885 | 33,072 | — 30.8 |
| Dist. 3: Upper Gulf | 358.2 | 426.3 | — 16.0 | 347.0 | 77,791 | 97,726 | — 20.4 |
| Dist. 4: Lower Gulf | 182.5 | 216.5 | — 15.7 | 171.8 | 38,000 | 50,790 | — 25.2 |
| Dist. 5: East Central | 26.6 | 36.4 | — 26.9 | 25.9 | 6,079 | 8,652 | — 29.7 |
| Dist. 6: Northeast | 234.7 | 302.1 | — 22.3 | 220.1 | 51,268 | 73,502 | — 30.3 |
| Dist. 7-B: North Central | 124.9 | 151.6 | — 17.6 | 122.4 | 27,952 | 34,905 | — 19.9 |
| Dist. 7-C: West Central | 126.1 | 144.2 | — 12.6 | 121.4 | 26,921 | 35,769 | — 24.7 |
| Dist. 8: West | 909.9 | 1,031.9 | — 11.8 | 826.0 | 185,162 | 246,160 | — 24.8 |
| Dist. 9: North | 186.7 | 201.9 | — 7.5 | 193.2 | 40,958 | 45,030 | — 9.1 |
| Dist. 10: Panhandle | 104.0 | 105.5 | — 1.4 | 106.4 | 22,555 | 22,230 | + 1.5 |
| Utah | 89.1 | 9.8 | +809.2 | 83.1 | 9,905 | 2,106 | +370.3 |
| Virginia | ..... | ..... | ..... | ..... | 5 | 3 | + 66.7 |
| Washington | ..... | ..... | ..... | ..... | 10 | ..... | ..... |
| West Virginia | 6.2 | 6.4 | — 3.1 | 6.2 | 1,272 | 1,274 | — 0.2 |
| Wyoming | 322.6 | 280.3 | + 15.1 | 301.9 | 64,432 | 61,504 | + 4.8 |

**Source:** Bureau of Mines and API. Texas Districts from API and do not necessarily agree with State totals.

looking for oil

# UNDER WATER?



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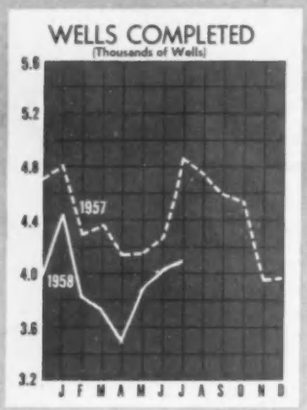
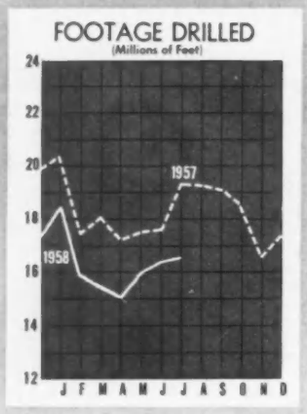
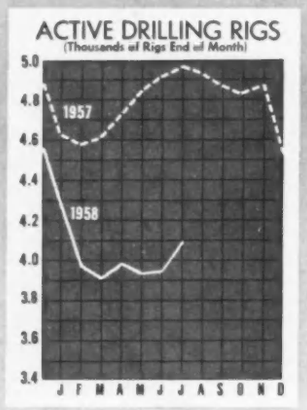
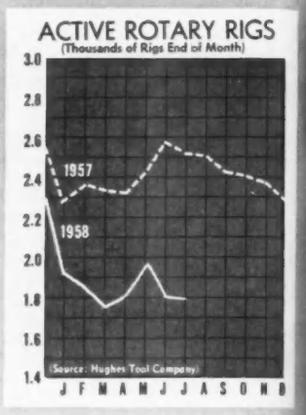
# Drilling Activities...




# U.S. well completions again exceed 4,000 during July

**July was the second consecutive month in which more than 4,000 new wells were completed in the U.S., and indications are that August completions will be of similar magnitude.**

New completions in July totaled 4,093, almost identical with the 4,129 completions in June. These figures compare with the completion of 3,910 wells in May, the low of 3,553 during April, 3,672 in March, and 3,781 during February.

A continuation of this drilling rate would mean the completion of 20,500 wells during the next five months. A total of 27,355 wells was completed during the first seven months of 1958, so the possibility of attaining World Oil's forecast of 47,952 wells in the U.S. during 1958 becomes increasingly likely.

A slight increase in the number of rigs in operation indicates completions should again be in excess of 4,000 during August. At the end of July, 4,098 rigs were in operation in the U.S., in contrast with 4,076 at the end of June, 3,938 at the close of May, 3,996 the end of April, and the low of 3,860 at the close of March.

Although slightly fewer wells were completed in July than in June, July completions had greater depths. Consequently, footage rose to 16,511,586 feet during July, in contrast with 16,414,001 feet in June. This was the greatest amount of footage drilled in any month since January.

**Below 1957 rates.** Despite the increase in wells and footage during recent months, 1958 rates remain far below 1957 volumes.

Well completions rose sharply in July last year, reaching 4,845, the highest level of 1957. However, this proved to be just a temporary upswing. Well completions declined steadily and rather sharply in subsequent months of 1957, reaching a low of less than 4,200 during the months of November and December.

The completion of 27,355 wells during the first seven months of 1958 is 11.5 percent below the 30,921 wells drilled during the same period of 1957. Footage during the first seven months of this year has totaled 113,052,428 feet, 11.5 percent less than the 127,845,739 feet drilled in the similar period of 1957.

**Gain in Texas.** Considerably more wells were completed in Texas during July than in the preceding month. A total of 1,531 new wells was completed in the state in July, compared with only 1,339 during June. The Lower Gulf Coast, North Central, West Texas, and North Texas regions all completed more wells in July than in June. This is the largest monthly completion rate in Texas since January.

Other states to complete more wells in July than in June were: Colorado, Illinois, Louisiana, Michigan, Mississippi, North Dakota, Utah and Wyoming.

The only states to complete more wells in July, 1958, than in July, 1957, were: Colorado, Michigan, Mississippi, North Dakota, Utah and West Virginia.

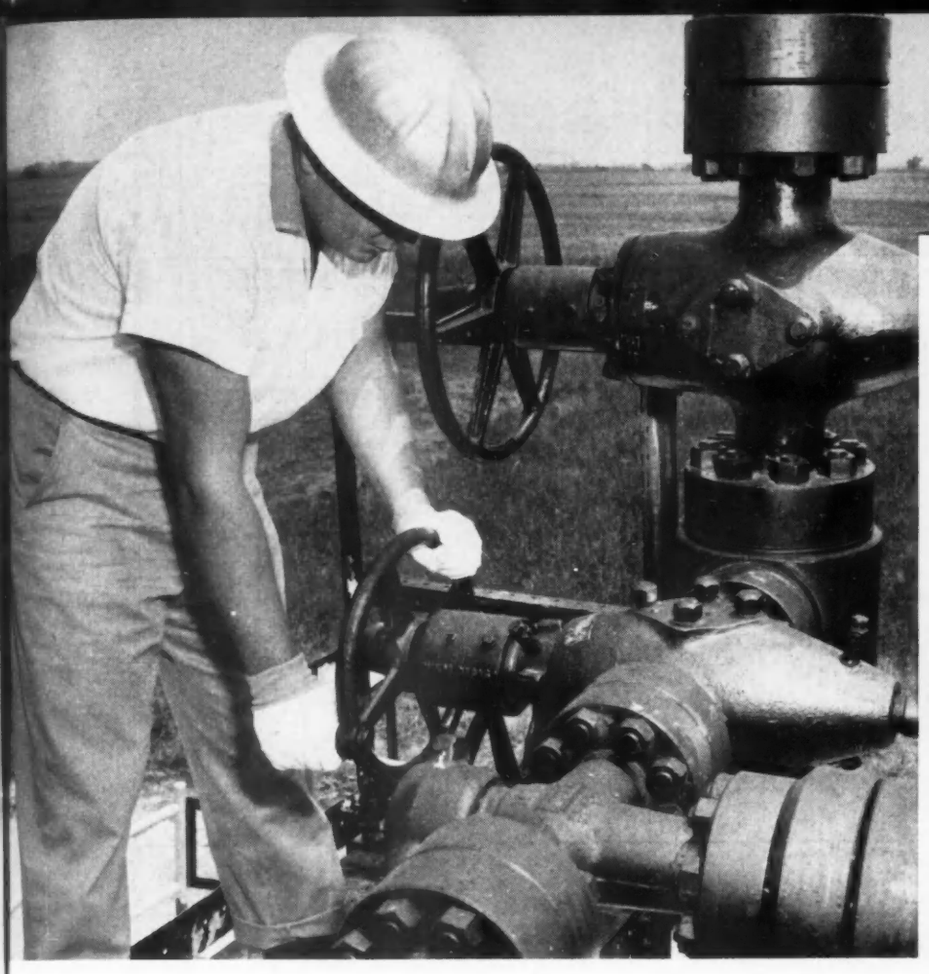
**Summary of U. S. Wildcat Drilling**

| ITEM | July, 1958 | June, 1958 | SEVEN MONTHS January—July 1958 | 1957 | Percent Diff. |
|---|---|---|---|---|---|
| **New Field Discoveries:** | | | | | |
| Oil | 55 | 65 | 430 | 472 | — 8.9 |
| Distillate | 5 | 6 | 56 | 70 | — 20.0 |
| Gas | 25 | 13 | 140 | 129 | + 8.5 |
| **Total Discoveries** | 85 | 84 | 626 | 671 | — 6.7 |
| Dry Wildcats | 772 | 734 | 4,872 | 5,894 | — 17.3 |
| **Total Wildcats** | 857 | 818 | 5,498 | 6,565 | — 16.3 |
| Percent Productive | 9.9 | 10.3 | 11.4 | 10.2 | ..... |
| Percent Dry | 90.1 | 89.7 | 88.6 | 89.8 | ..... |

**Summary of U. S. Drilling Activity**

| ITEM | July, 1958 | June, 1958 | SEVEN MONTHS January—July 1958 | 1957 | Percent Diff. |
|---|---|---|---|---|---|
| **New Wells Completed:** | | | | | |
| Oil | 2,026 | 1,991 | 13,719 | 16,279 | — 15.7 |
| Distillate | 52 | 43 | 438 | 393 | + 11.5 |
| Gas | 378 | 370 | 2,337 | 2,104 | + 11.1 |
| Service | 102 | 125 | 762 | 609 | + 25.1 |
| Dry | 1,535 | 1,600 | 10,099 | 11,536 | — 12.5 |
| **Total Wells** | 4,093 | 4,129 | 27,355 | 30,921 | — 11.5 |
| **Footage Drilled (Mln. of Feet)** | 16.6 | 16.4 | 113.1 | 127.8 | — 11.5 |

*Details on page 30*



# *Creative Engineering* maintains the leadership of W-K-M® Through-Conduit Gate Valves

Oil men all over the world pronounce this valve the best production valve they ever used.

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W-K-M's creative engineering is the reason why. It studies your valve problems, it invents solutions to them, it improves on solutions already made, it maintains W-K-M's leadership in valve design, and valve production.

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**ON HAND.** The most used sizes of W-K-M gate valves are carried by supply stores everywhere. Special sizes and special designs are produced as you need them.

## For 10,000 and 15,000 psi Working Pressure W-K-M Balanced Stem Valves

W-K-M designed and built this valve to solve a valve operation problem posed by the very high pressures today's oil men must control.

The "balancing stem" is attached to the bottom of the gate to balance out body pressure that would be acting against a single stem. This eliminates the thrust load carried by bearings and threads in single stem valves. Whatever the pressure, the only loads to be overcome in opening or closing this valve are packing friction and normal operating loads. Thus very little effort is required to operate the handwheel.

The design includes parallel expanding gates, two thrust bearings, super-finished stems, and other important features that have established W-K-M's leadership

**Sizes:** 15,000 lb. W.P.: 1⅜", 1 11/16", 1 13/16", 2 1/16", 2⅜"
10,000 lb. W.P.: 2", 2½", 3", 3½"

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5814

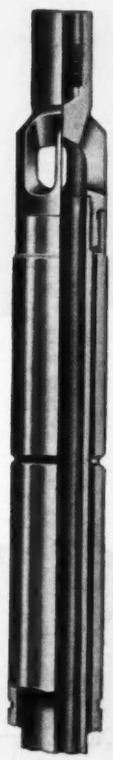
# U. S. Drilling Activity in July and First Seven Months, 1958-1957

| STATE or DISTRICT | TOTAL NEW WELLS COMPLETED AND FOOTAGE DRILLED: DETAILS FOR JULY, 1958 Oil | Dist. | Gas | Dry | Service Wells | TOTAL NEW WELLS July, 1958 | June, 1958 | July, 1957 | Total Footage July, 1958 | DETAILS FOR JANUARY-JULY NEW WELLS 1958 | 1957 | Percent Diff. | FOOTAGE 1958 | 1957 | WILDCAT DRILLING IN JULY AND FIRST SEVEN MONTHS, 1958-1957 DETAILS FOR JULY, 1958 Oil | Dist. | Gas | Dry | Total Wildcats | DETAILS FOR JANUARY-JULY Oil | Dist. | Gas | Dry | TOTAL WILDCATS 1958 | 1957 | DRILLING RIGS IN OPERATION (Riggin up Drilling, Temp. Shut-Down) July 31, 1958 | June 30, 1958 | July 31, 1957 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alabama | 4 | .... | .... | 3 | .... | 7 | 7 | 5 | 51,079 | 45 | 67 | — 32.8 | 383,387 | 588,211 | .... | .... | .... | 3 | 3 | .... | .... | .... | 16 | 16 | 24 | 14 | 7 | 7 |
| Arkansas | 44 | 1 | .... | 20 | .... | 65 | 67 | 109 | 195,374 | 395 | 616 | — 35.9 | 1,340,536 | 1,848,600 | .... | 1 | .... | 8 | 9 | 6 | 1 | 6 | 78 | 91 | 93 | 54 | 39 | 64 |
| California | 58 | .... | 4 | 38 | .... | 100 | 108 | 176 | 495,451 | 848 | 1,265 | — 33.0 | 3,987,139 | 5,388,124 | 1 | .... | .... | 23 | 24 | 5 | .... | 1 | 135 | 141 | 214 | 136 | 127 | 177 |
| Colorado | 13 | .... | 14 | 70 | .... | 97 | 81 | 66 | 486,537 | 478 | 468 | + 2.1 | 2,486,373 | 2,441,285 | 2 | .... | 5 | 53 | 60 | 17 | .... | 10 | 230 | 257 | 286 | 74 | 58 | 65 |
| Florida | .... | .... | .... | 2 | .... | 2 | .... | 2 | 22,947 | 4 | 8 | — 50.0 | 41,889 | 57,082 | .... | .... | .... | 2 | 2 | .... | .... | .... | 4 | 4 | 8 | 2 | 1 | 1 |
| Georgia | .... | .... | .... | .... | .... | .... | .... | .... | ..... | .... | 3 | ..... | ..... | 18,955 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 3 | 1 | 1 | .... |
| Illinois | 111 | .... | 8 | 96 | 1 | 216 | 199 | 224 | 513,415 | 1,234 | 1,411 | — 12.6 | 2,852,393 | 3,182,127 | .... | .... | .... | 55 | 55 | 2 | .... | .... | 311 | 313 | 429 | 282 | 271 | 255 |
| Indiana | 24 | .... | .... | 46 | 3 | 73 | 84 | 35 | 123,500 | 410 | 358 | + 14.5 | 669,496 | 570,410 | .... | .... | .... | 21 | 21 | 2 | .... | 1 | 108 | 111 | 99 | 102 | 109 | 119 |
| Kansas | 138 | .... | 24 | 154 | 5 | 321 | 338 | 378 | 1,135,957 | 2,004 | 2,401 | — 16.5 | 6,920,024 | 8,551,554 | 7 | .... | 4 | 75 | 86 | 67 | .... | 17 | 454 | 538 | 580 | 396 | 455 | 581 |
| Kentucky | 59 | .... | 11 | 69 | .... | 139 | 152 | 176 | 223,322 | 800 | 920 | — 13.1 | 1,162,677 | 1,385,158 | 1 | .... | .... | 6 | 7 | 4 | .... | 1 | 32 | 37 | 69 | 120 | 102 | 126 |
| Louisiana | 122 | 15 | 22 | 143 | .... | 302 | 293 | 314 | 2,393,997 | 1,957 | 2,104 | — 7.0 | 16,042,581 | 17,102,743 | 2 | 2 | .... | 59 | 63 | 21 | 12 | 4 | 285 | 322 | 334 | 347 | 338 | 422 |
| North Louisiana | 46 | .... | 10 | 59 | .... | 115 | 112 | 132 | 418,771 | 675 | 754 | — 10.5 | 2,590,817 | 2,805,907 | 1 | .... | .... | 24 | 25 | 8 | .... | .... | 77 | 85 | 93 | 105 | 79 | 78 |
| South Louisiana | 76 | 15 | 12 | 84 | .... | 187 | 181 | 182 | 1,975,226 | 1,282 | 1,350 | — 5.0 | 13,451,764 | 14,296,836 | 1 | 2 | .... | 35 | 38 | 13 | 12 | 4 | 208 | 237 | 241 | 242 | 259 | 344 |
| * Gulf of Mexico | 20 | 1 | 3 | 17 | .... | 41 | 41 | 55 | 398,340 | 300 | 403 | — 25.6 | 2,865,707 | 4,086,919 | .... | .... | .... | 3 | 3 | 3 | 1 | .... | 22 | 26 | 46 | 42 | 50 | 92 |
| Michigan | 19 | .... | 2 | 21 | .... | 42 | 28 | 28 | 133,877 | 221 | 220 | + 0.5 | 655,271 | 629,028 | 2 | .... | .... | 12 | 14 | 5 | .... | 2 | 66 | 73 | 83 | 69 | 68 | 74 |
| Mississippi | 17 | .... | .... | 18 | .... | 35 | 28 | 31 | 356,990 | 212 | 209 | + 1.4 | 1,923,154 | 1,474,319 | 4 | .... | .... | 8 | 12 | 9 | 1 | .... | 81 | 91 | 112 | 40 | 51 | 42 |
| Missouri | .... | .... | .... | 2 | .... | 2 | 2 | 2 | 1,066 | 10 | 3 | +233.3 | 6,272 | 2,751 | .... | .... | .... | 2 | 2 | .... | .... | .... | 3 | 3 | 4 | 2 | 1 | .... |
| Montana | 13 | .... | .... | 5 | .... | 18 | 30 | 44 | 68,430 | 179 | 222 | — 19.4 | 983,732 | 1,157,807 | 2 | .... | .... | 5 | 7 | 5 | 1 | 4 | 66 | 76 | 69 | 46 | 36 | 48 |
| Nebraska | 14 | .... | .... | 40 | .... | 54 | 84 | 84 | 328,162 | 369 | 507 | — 27.2 | 2,197,084 | 2,989,575 | 1 | .... | .... | 22 | 23 | 18 | .... | .... | 152 | 170 | 263 | 42 | 29 | 49 |
| Nevada | .... | .... | .... | .... | .... | .... | .... | .... | ..... | ..... | 3 | —100.0 | ..... | 5,718 | .... | .... | .... | .... | .... | .... | .... | .... | .... | ..... | 3 | 1 | 1 | 3 |
| New Mexico | 74 | .... | 61 | 31 | .... | 166 | 176 | 191 | 743,878 | 1,135 | 1,307 | — 13.2 | 5,376,733 | 5,963,018 | .... | .... | 2 | 18 | 20 | 22 | 2 | 15 | 121 | 160 | 178 | 195 | 177 | 194 |
| Southeast | 48 | .... | 3 | 21 | .... | 72 | 87 | 104 | 325,405 | 583 | 813 | — 28.3 | 2,905,719 | 3,956,667 | .... | .... | .... | 13 | 13 | 16 | 2 | 4 | 73 | 95 | 119 | 56 | 73 | 105 |
| Northwest | 26 | .... | 58 | 10 | .... | 94 | 89 | 87 | 418,473 | 552 | 494 | + 11.7 | 2,471,014 | 2,006,351 | .... | .... | 2 | 5 | 7 | 6 | .... | 11 | 48 | 65 | 59 | 139 | 104 | 89 |
| New York | 15 | .... | 1 | 2 | 17 | 35 | 48 | 48 | 56,250 | 323 | 279 | + 15.8 | 499,050 | 464,000 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 42 | 42 | 62 |
| North Dakota | 25 | .... | .... | 25 | .... | 50 | 28 | 21 | 302,174 | 246 | 153 | + 60.8 | 1,642,211 | 1,082,933 | 2 | .... | .... | 16 | 18 | 17 | .... | .... | 60 | 77 | 67 | 40 | 38 | 28 |
| Ohio | 47 | .... | 20 | 20 | .... | 87 | 90 | 106 | 228,459 | 568 | 575 | — 1.2 | 1,469,030 | 1,389,913 | .... | .... | .... | 1 | 1 | .... | .... | .... | 4 | 4 | 5 | 232 | 228 | 224 |
| Oklahoma | 263 | 10 | 34 | 190 | 29 | 526 | 743 | 552 | 1,724,823 | 4,175 | 3,361 | + 24.2 | 13,188,830 | 12,207,914 | 9 | 1 | 4 | 51 | 65 | 41 | 7 | 20 | 395 | 443 | 377 | 442 | 455 | 618 |
| Pennsylvania | 18 | .... | 23 | 5 | 8 | 54 | 65 | 91 | 152,815 | 338 | 539 | — 37.3 | 793,303 | 1,482,008 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 26 | 162 | 160 | 184 |
| South Dakota | .... | .... | .... | .... | .... | .... | .... | 2 | ..... | 3 | 27 | — 88.9 | 16,991 | 105,867 | .... | .... | .... | .... | .... | .... | .... | .... | 3 | 3 | 25 | 2 | 1 | 1 |
| Texas | 874 | 26 | 108 | 484 | 39 | 1,531 | 1,339 | 1,986 | 6,027,138 | 10,282 | 12,997 | — 20.9 | 43,807,507 | 54,302,419 | 20 | 1 | 9 | 301 | 331 | 181 | 32 | 49 | 2,118 | 2,380 | 3,004 | 933 | 950 | 1,304 |
| Dist. 1: South Central | 33 | 1 | 5 | 25 | .... | 64 | 91 | 101 | 152,637 | 580 | 797 | — 27.2 | 1,420,341 | 1,994,748 | .... | .... | .... | 18 | 18 | 9 | 1 | 1 | 202 | 213 | 225 | 36 | 34 | 49 |
| Dist. 2: Middle Gulf | 14 | 7 | 7 | 29 | .... | 57 | 35 | 84 | 326,546 | 418 | 447 | — 6.5 | 2,511,150 | 2,789,435 | 2 | .... | 1 | 23 | 26 | 8 | 6 | 7 | 109 | 130 | 159 | 37 | 27 | 39 |
| Dist 3: Upper Gulf | 39 | 7 | 3 | 45 | .... | 94 | 101 | 127 | 598,667 | 761 | 1,003 | — 24.1 | 4,848,701 | 6,676,701 | .... | .... | .... | 28 | 28 | 5 | 3 | 5 | 192 | 205 | 269 | 72 | 68 | 112 |
| * Gulf of Mexico | .... | .... | .... | .... | .... | .... | 3 | 1 | ..... | 8 | 6 | + 33.3 | 62,356 | 44,159 | .... | .... | .... | .... | .... | .... | .... | 1 | 5 | 6 | 3 | 1 | 2 | 1 |
| Dist 4: Lower Gulf-S.W. | 25 | 10 | 12 | 62 | .... | 109 | 88 | 119 | 526,246 | 718 | 839 | — 14.4 | 3,649,377 | 4,380,648 | 2 | 1 | 1 | 43 | 47 | 14 | 10 | 4 | 264 | 292 | 255 | 64 | 61 | 85 |
| * Gulf of Mexico | .... | .... | .... | 1 | .... | 1 | 2 | 2 | 8,236 | 7 | 12 | — 41.7 | 75,300 | 116,229 | .... | .... | .... | .... | .... | .... | .... | .... | 2 | 2 | ..... | ..... | ..... | 3 |
| Dist. 5: East Central | 5 | .... | 3 | 21 | .... | 29 | 20 | 18 | 89,254 | 114 | 96 | + 18.8 | 407,765 | 526,079 | .... | .... | .... | 18 | 18 | 2 | 1 | .... | 66 | 69 | 67 | 16 | 14 | 20 |
| Dist. 6: Northeast | 39 | 1 | 4 | 24 | .... | 68 | 65 | 95 | 317,403 | 495 | 641 | — 22.8 | 2,589,805 | 3,479,537 | .... | .... | .... | 16 | 16 | 4 | 2 | 2 | 119 | 127 | 144 | 53 | 58 | 64 |
| Dist. 7-B: North Central | 99 | .... | 10 | 83 | 3 | 195 | 176 | 276 | 602,984 | 1,255 | 1,607 | — 21.9 | 4,071,788 | 5,467,261 | 3 | .... | 1 | 51 | 55 | 44 | 3 | 6 | 382 | 435 | 583 | 61 | 68 | 106 |
| Dist. 7-C: West Central | 45 | .... | 1 | 21 | 3 | 70 | 71 | 95 | 329,202 | 477 | 716 | — 33.4 | 2,403,995 | 3,220,444 | 1 | .... | .... | 18 | 19 | 20 | .... | 3 | 119 | 142 | 221 | 64 | 59 | 90 |
| Dist. 8: West | 287 | .... | 6 | 42 | 16 | 351 | 324 | 447 | 1,564,754 | 2,499 | 2,968 | — 15.8 | 12,047,000 | 14,558,830 | 8 | .... | .... | 31 | 39 | 42 | 1 | 4 | 252 | 299 | 305 | 291 | 308 | 376 |
| Dist. 9: North | 234 | .... | 16 | 114 | 17 | 381 | 253 | 469 | 982,615 | 2,207 | 3,029 | — 27.1 | 6,431,749 | 7,937,051 | 4 | .... | 1 | 49 | 54 | 25 | 2 | 5 | 357 | 389 | 705 | 153 | 174 | 231 |
| Dist. 10: Panhandle | 54 | .... | 41 | 18 | .... | 113 | 115 | 155 | 536,830 | 758 | 854 | — 11.3 | 3,425,836 | 3,371,685 | .... | .... | 5 | 6 | 11 | 8 | 3 | 12 | 56 | 79 | 71 | 86 | 79 | 132 |
| Utah | 33 | .... | 2 | 15 | .... | 50 | 24 | 20 | 274,225 | 272 | 112 | +142.9 | 1,523,464 | 646,206 | .... | .... | .... | 12 | 12 | .... | .... | .... | 53 | 53 | 53 | 41 | 43 | 58 |
| Washington | .... | .... | .... | .... | .... | .... | .... | 1 | ..... | 4 | 3 | + 33.3 | 20,794 | 16,329 | .... | .... | .... | .... | .... | .... | .... | .... | 3 | 3 | 3 | .... | .... | 1 |
| West Virginia | 16 | .... | 39 | 6 | .... | 61 | 66 | 58 | 170,045 | 439 | 342 | + 28.4 | 1,140,923 | 923,950 | .... | .... | .... | .... | .... | .... | .... | 6 | 4 | 10 | 12 | 192 | 201 | 170 |
| Wyoming | 25 | .... | 5 | 26 | .... | 56 | 47 | 93 | 324,983 | 379 | 437 | — 13.3 | 1,839,533 | 1,851,194 | 2 | .... | 1 | 15 | 18 | 8 | .... | 3 | 98 | 109 | 138 | 84 | 83 | 101 |
| Others | .... | .... | .... | 4 | .... | 4 | 2 | 2 | 16,692 | 25 | 4 | +525.0 | 82,051 | 16,541 | .... | .... | .... | 4 | 4 | .... | .... | 1 | 12 | 13 | 4 | 5 | 4 | 5 |
| Total United States | 2,026 | 52 | 378 | 1,535 | 102 | 4,093 | 4,129 | 4,845 | 16,551,586 | 27,355 | 30,921 | — 11.5 | 113,052,428 | 127,845,739 | 55 | 5 | 25 | 772 | 857 | 430 | 56 | 140 | 4,872 | 5,498 | 6,565 | 4,098 | 4,076 | 4,983 |
| Total Western Canada | 113 | .... | 14 | 57 | .... | 184 | 177 | 286 | 814,286 | 1,306 | 1,742 | — 25.0 | 6,892,922 | 8,135,559 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 229 | 213 | 220 |

* Gulf of Mexico wells are included in their respective district totals.

# the most useful mechanical inventions are often the least complex

*another* ..... oilmaster EXCLUSIVE



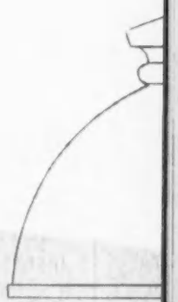
## oil lubricated plunger

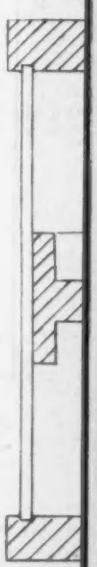
One of the few completely new developments in downwell pumping equipment today—the Oil Lubricated Plunger, has created quite a stir in production circles of the industry. Using a combination of very simple hydraulic principles, coupled with the most practical mechanical design, the Oil Lubricated Plunger actually establishes a new set of standards for plunger performance.

The unique principle employs the use of an annular chamber within the plunger body to separate clean oil from sand and water. A continuous film of clean oil is supplied by pump action to lubricate the close fit between barrel and plunger.

Problems of abrasion have been materially reduced as a result of this design. Actual field tests continue to yield evidence of superior performance in all water cut conditions. Testimonials from operators bear out the wide acceptance of this unique principle as an important engineering achievement.

The range of usage for the Oil Lubricated Plungers seems virtually unlimited. In casing, tubing and insert installations its performance has proven commendable.





**Ask your OILMASTER representative to demonstrate the advantages of the Oil Lubricated Plunger. Write Box 64, Los Nietos, Calif. for literature.**

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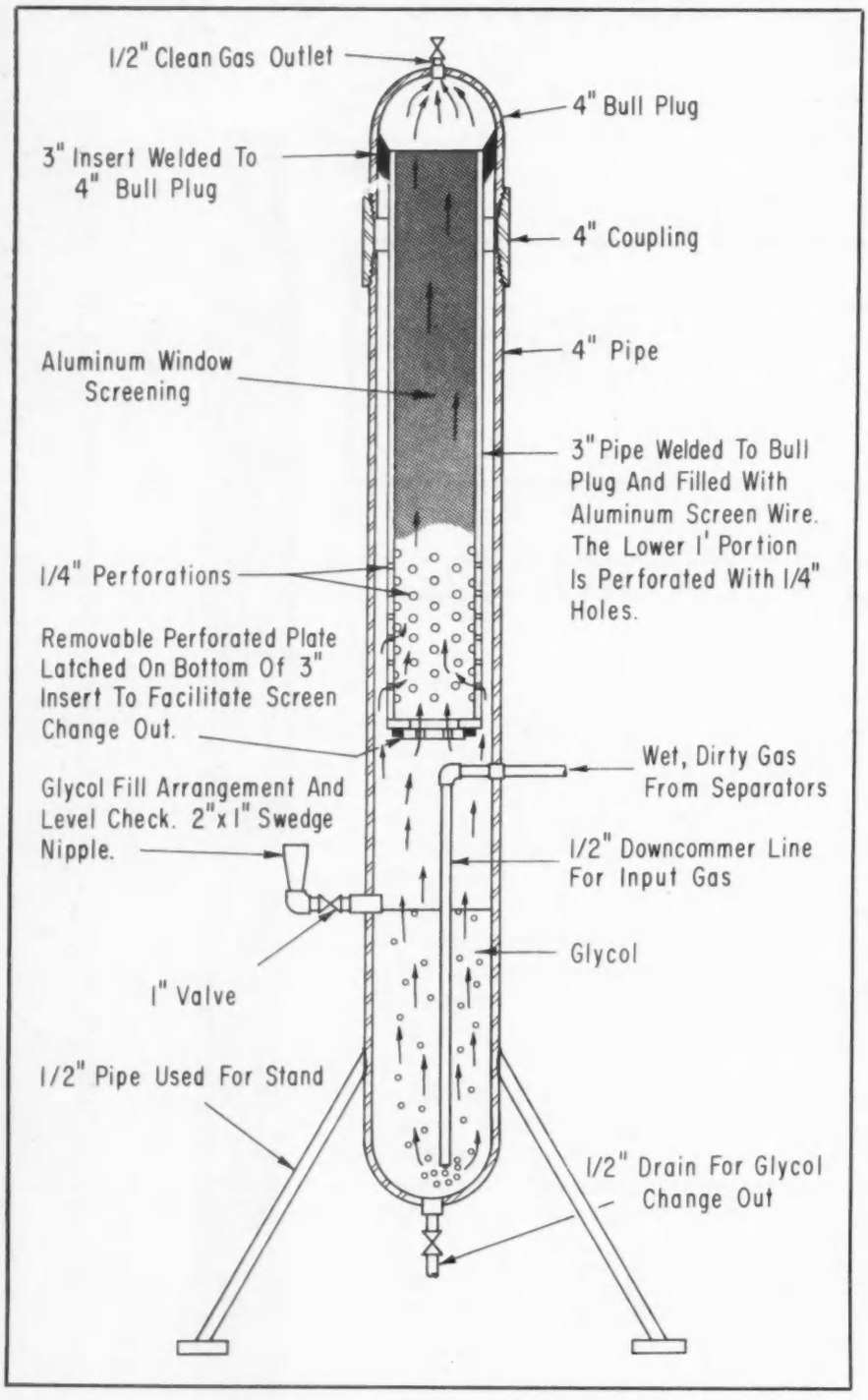
# Practical Operating Hints

## These **How-To-Do-It** Ideas Can Save You Money

***$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas***


1/2" Clean Gas Outlet
4" Bull Plug
3" Insert Welded To 4" Bull Plug
4" Coupling
4" Pipe
Aluminum Window Screening
3" Pipe Welded To Bull Plug And Filled With Aluminum Screen Wire. The Lower 1' Portion Is Perforated With 1/4" Holes.
1/4" Perforations
Removable Perforated Plate Latched On Bottom Of 3" Insert To Facilitate Screen Change Out.
Wet, Dirty Gas From Separators
Glycol Fill Arrangement And Level Check. 2"x1" Swedge Nipple.
1/2" Downcommer Line For Input Gas
Glycol
1" Valve
1/2" Pipe Used For Stand
1/2" Drain For Glycol Change Out

## Scrubber Provides Clean Supply of Gas

An easily constructed supply gas scrubber for wet gas is shown. The unit can be constructed in the field and provides exceptionally clean supply gas for pneumatic operated equipment. The scrubber is especially applicable for use on tank batteries which have a considerable number of pneumatic valves, automatic tank switching equipment etc., but where only wet separator gas is available for supply purposes.

The scrubber consists of a 4-inch piece of line pipe approximately 5½ feet long with a 3-inch portion of line pipe 3 feet long inside. The 4-inch pipe is bull plugged on one end and orange peeled on the other. A stand is provided by welding 3½-inch pieces of pipe on the lower portion.

The 3-inch pipe is perforated from the bottom up to a total height of 1 foot. The removable latched bottom plate is also perforated and provides a means of changing out the aluminum wire screen contained in the 3-inch pipe.

Wet gas enters the vessel as indicated and is bubbled through a glycol solution. It then passes through the perforated interval of the 3-inch insert and through the wire screen. The dried gas is discharged through the ½-inch connection on top of the unit to the supply gas system.

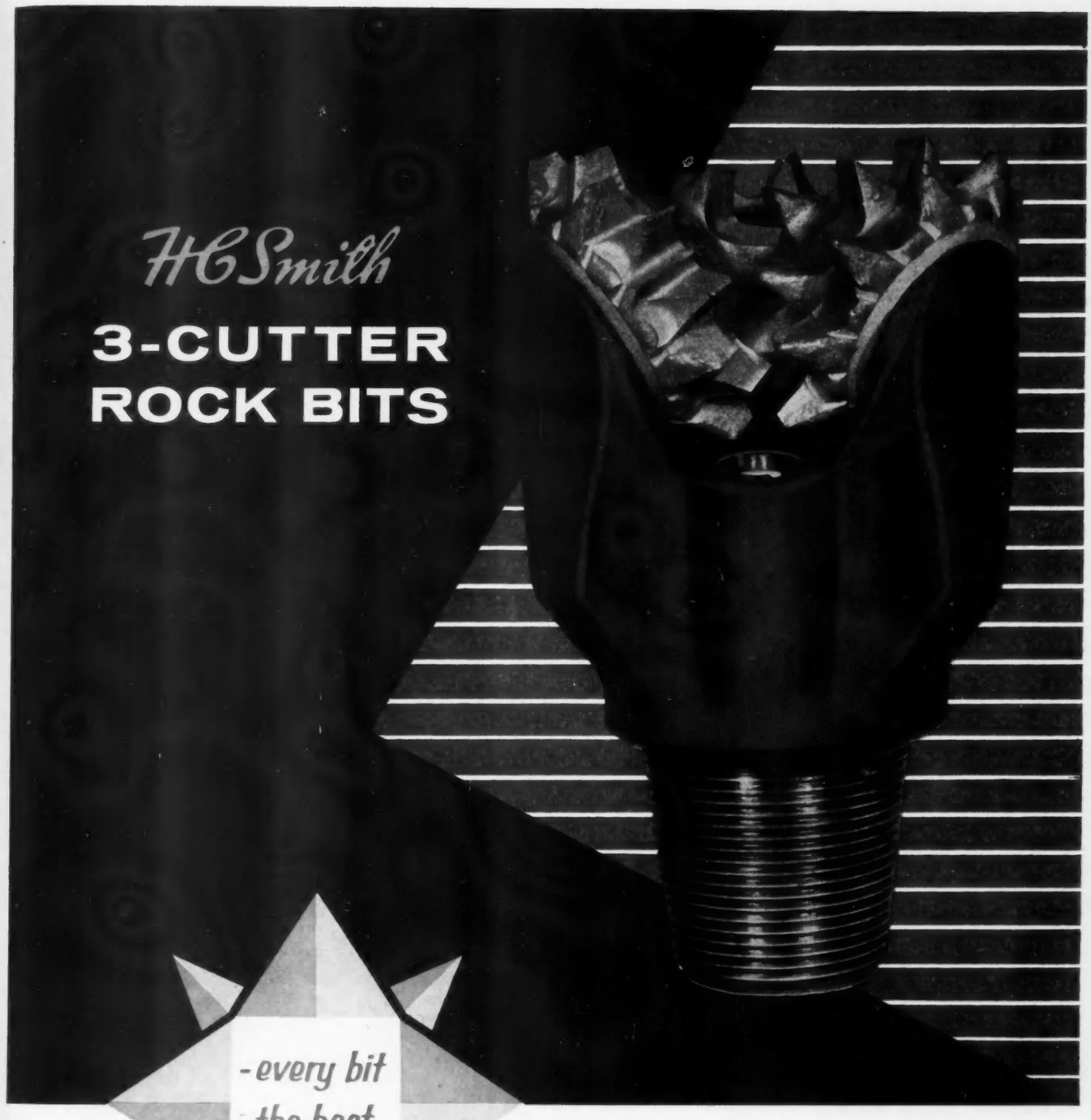
A level check and fill arrangement is provided on the side of the scrubber so that glycol may be changed out without dismantling the entire unit. The drain valve on the bottom is used to drain the glycol when necessary.

## Mousehole Connection Made Minus Mousehole

Falcon Seaboard Drilling Co. is saving rig time by making mousehole connections without a mousehole. A rig operating in Osage County, Okla., equipped with a 96-foot mast required that the kelly be set back in the rathole each time a connection was made. By using this new technique the crew is making connections without setting back the kelly.

The following hook-up is necessary as shown in Figure 1:

1. One set of short (4-foot) elevator bails.
2. Two sets of 4½-inch drill pipe elevators; one set in the top of the bails, hung upside down and one set in the bottom of the bails, hung in the regular manner.
3. The bails and elevators above are

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**PRODUCTION APPLICATIONS**

**SINGLE ZONE** Normal Completion

**SINGLE ZONE** Permanent Type Well Completions

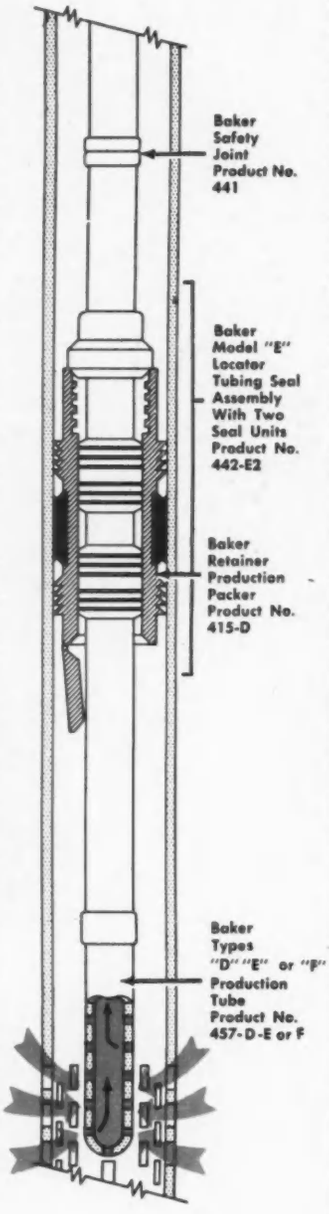
Baker Retainer Production Packer Product No. 415-D

## FEATURES

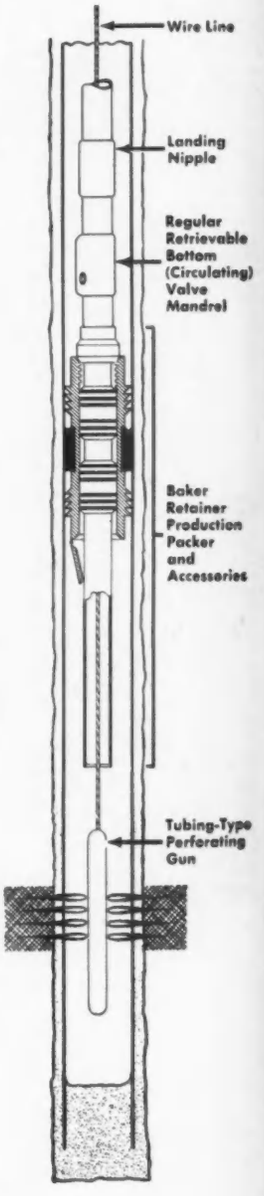
Holds any pressure from either above or below that is safe for the casing, even under temperatures in excess of 300°F.

Pack-off is independent of set-down weight or tension. Tubing string is free; just pick up (or unlatch and pick up) to remove it.

Use it as a squeeze and testing tool or as a temporary or permanent bridge plug in conjunction with any production application.


Baker Safety Joint Product No. 441
Baker Model "E" Locator Tubing Seal Assembly With Two Seal Units Product No. 442-E2
Baker Retainer Production Packer Product No. 415-D
Baker Types "D" "E" or "F" Production Tube Product No. 457-D-E or F

Illustrates Packer set in casing with Locator Tubing Seal Assembly and Production Tube installed for single-zone production.




Illustrates typical Permanent-Type Well Completion Hook-Up showing perforating operation through and below the Packer.

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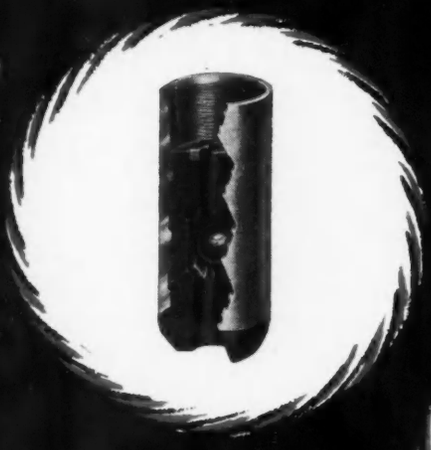

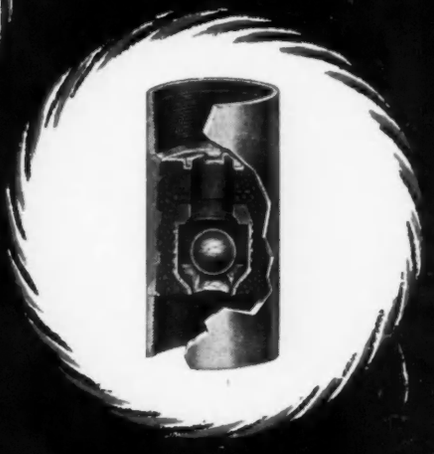

## LARKIN CEMENTING EQUIPMENT

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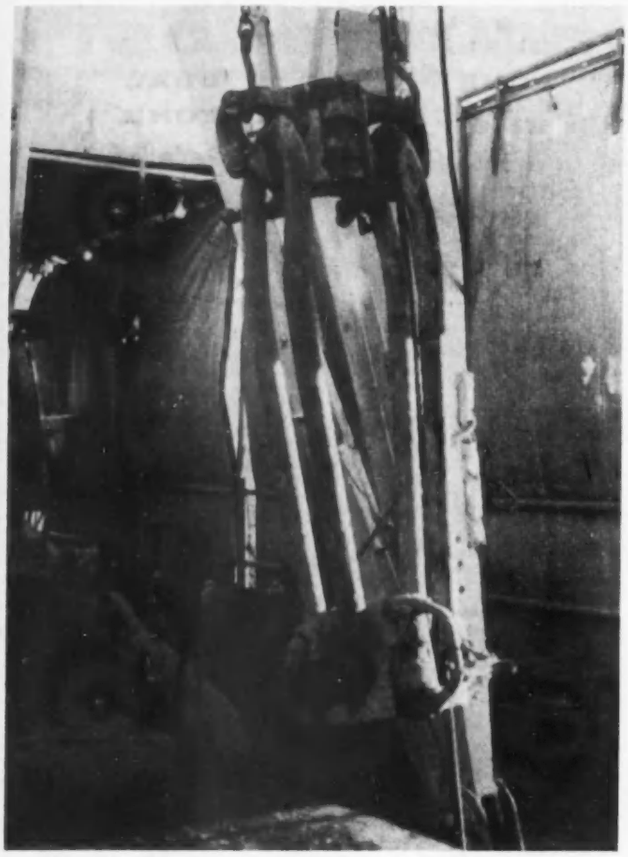


FIGURE 1

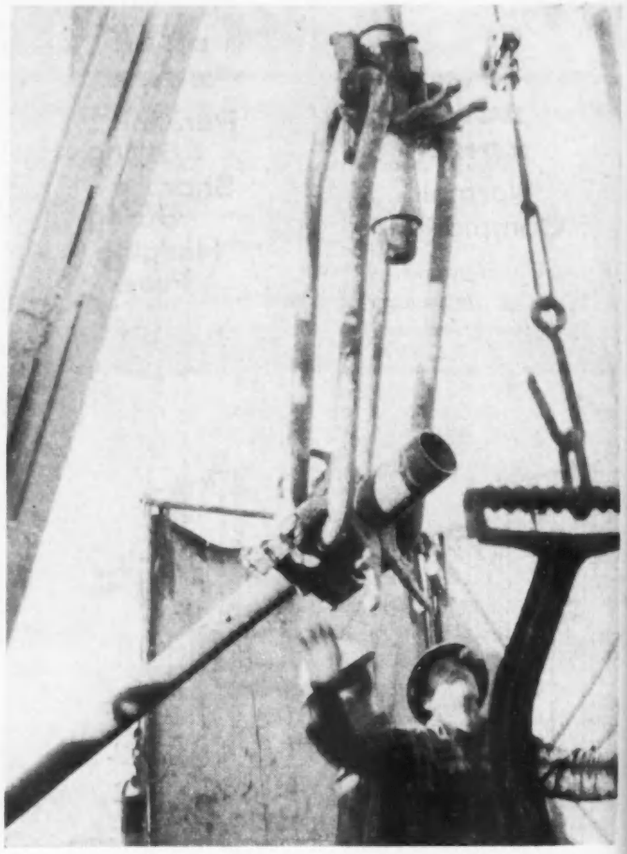


FIGURE 2

suspended in the mast near the A-frame on the off side, on a ½-inch cable. The cable is securely clamped to the mast approximately 30 feet up.

4. The saver-sub on the end of the kelly must be turned to fit 4½-inch elevators.

With this hook-up, a mousehole connection without a mousehole is accomplished in the following manner:

1. The pipe is picked up and the kelly broken off in the usual manner.
2. The top set of elevators (hung upside down) in the bails are latched onto the kelly saver-sub.
3. The bottom set of elevators are latched onto the joint laying in the V-door.
4. As the kelly is picked up, the joint to be added is pulled in the door, raised high enough to clear the box in the rotary, set in the box and made up. (See Figure 2)
5. The pipe is then picked up, the slips pulled and the added joint lowered into the hole.
6. The slips are set again, and both sets of elevators are unlatched and removed.
7. The kelly is then made up in the box of the joint added, the slips pulled and it's "hole-getting-time" again.

## Road Oiling Operations Simplified With Device

This easily installed mechanism has been used to open foot valves on field tank trucks with considerable success. The device is a valuable time saver in areas where lease roads are oiled with tank bottom by means of trucks.

A discarded hand brake lever and rods were obtained from an old truck. The equipment was installed as shown in the photograph. A post is welded opposite the foot valve at the rear of the truck. The rods are attached and connected to the valve. By manipulating the brake lever, the rods are actuated by the linkage and the foot valve is opened or closed as desired.

The mechanism speeds up operations since the foot valve is automatically operated from the cab of the truck. No time is lost in stopping to manually operate the valve.

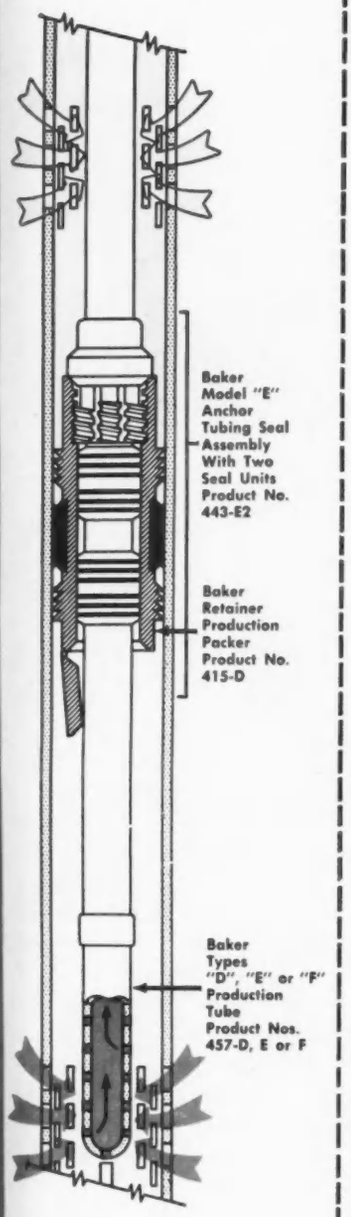
## Choke Change Is Speeded With Quick-Acting Union

When it is desired to flow a high pressure gas well prior to installing a line heater, a simple means of preventing the flow line from freezing downstream of the choke is to place the choke nipple on the end of the line at the burning pit.

The line is connected to the christmas tree in the normal manner. The choke is removed from the wellhead so that no pressure drop will take place at that point. The line is laid to the pit and the choke nipple and bean installed using a quick acting union. Chokes can easily be changed by loosening the quick union and removing the choke nipple from the line.

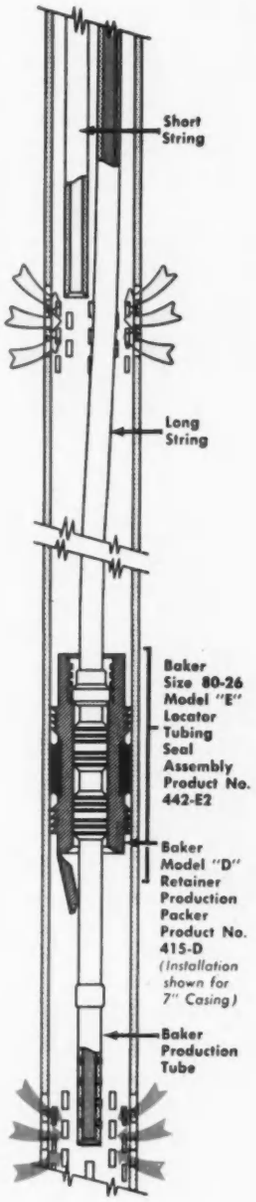
This method considerably speeds up choke changing operations. The flow line is also easily tested by means of well pressure or pump truck. Install-

## DUAL ZONE
## Normal Completion


Baker Model "E" Anchor Tubing Seal Assembly With Two Seal Units Product No. 443-E2
Baker Retainer Production Packer Product No. 415-D
Baker Types "D", "E" or "F" Production Tube Product Nos. 457-D, E or F

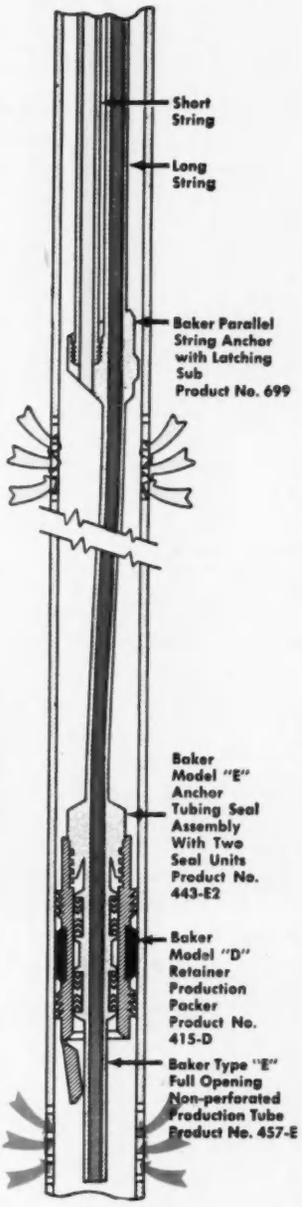
Illustrates Packer set in casing, with anchored production string for dual-zone production. Tubing can be released from Packer by rotating to right.

## DUAL ZONE
## Parallel String Short String Hanging Free


Short String
Long String
Baker Size 80-26 Model "E" Locator Tubing Seal Assembly Product No. 442-E2
Baker Model "D" Retainer Production Packer Product No. 415-D (Installation shown for 7" Casing)
Baker Production Tube

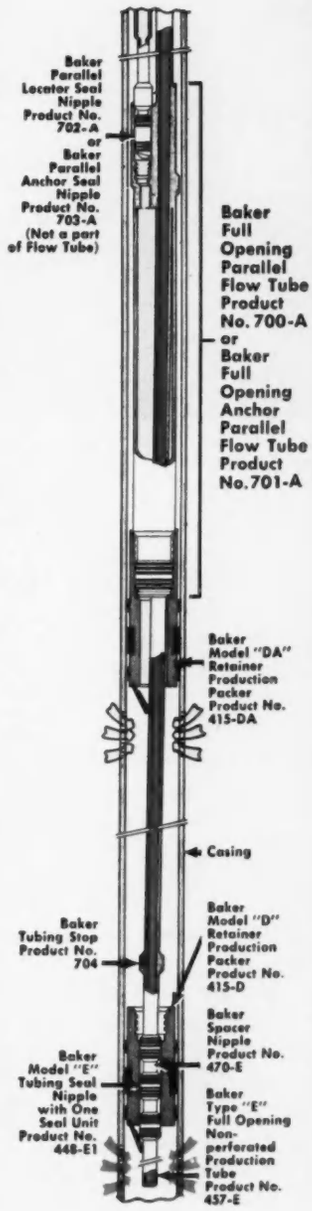
Permits removal of either string independently of the other regardless of sequence. Full-Opening (Tubing I.D.) Long String to lower zone.

## DUAL ZONE
## Parallel String Short String Anchored


Short String
Long String
Baker Parallel String Anchor with Latching Sub Product No. 699
Baker Model "E" Anchor Tubing Seal Assembly With Two Seal Units Product No. 443-E2
Baker Model "D" Retainer Production Packer Product No. 415-D
Baker Type "E" Full Opening Non-perforated Production Tube Product No. 457-E

Permits removal of either string independently of the other, however long string must be run first. Short string pulled first. Full-Opening (Tubing I.D.) Long String.

## DUAL ZONE
## Parallel String Two-Packer Hook-up


Baker Parallel Locator Seal Nipple Product No. 702-A or Baker Parallel Anchor Seal Nipple Product No. 703-A (Not a part of Flow Tube)
Baker Full Opening Parallel Flow Tube Product No. 700-A or Baker Full Opening Anchor Parallel Flow Tube Product No. 701-A
Baker Model "DA" Retainer Production Packer Product No. 415-DA
Casing
Baker Tubing Stop Product No. 704
Baker Model "D" Retainer Production Packer Product No. 415-D
Baker Spacer Nipple Product No. 470-E
Baker Model "E" Tubing Seal Nipple with One Seal Unit Product No. 448-E1
Baker Type "E" Full Opening Non-perforated Production Tube Product No. 457-E

Illustrates Two-Packer parallel string installation with each zone confined to its individual tubing string with full-opening to lower zone for use of all permanent-type completion tools.

ing a choke bean on the end of the line which has been filled with welding flux effectively blanks the line off into a closed system. Pressure is applied and the line checked for leaks.

An additional safety measure applicable in this type of testing is to install a tee "running" in the line upstream of the choke nipple. A ½-inch tapped bull plug with a ½-inch needle valve is placed in the open end of the tee. If the choke should become plugged, well pressure will equalize on the flow line. By closing the well master valve, the entire flow line can be safely bled off through the ½-inch needle valve.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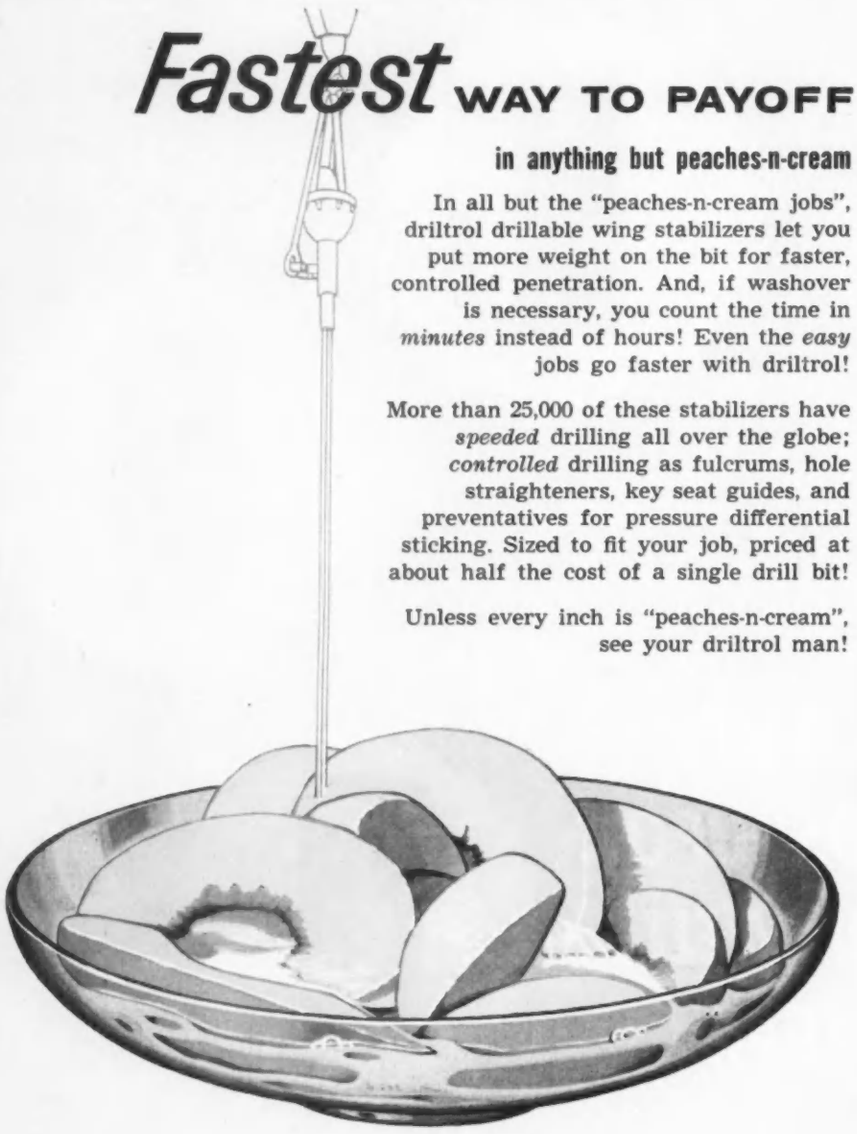

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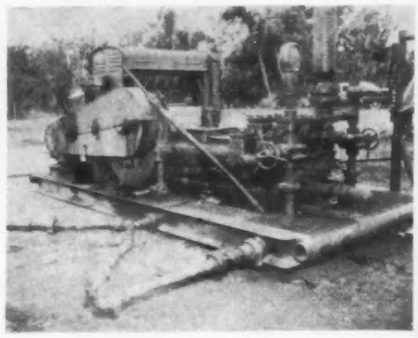

## Auxiliary Pump Unitized To Allow Quick Rig-Ups

Where mud pumps are used to mix mud for workover jobs, the outlet lines may be welded into the base of the unit with quick acting unions sticking out for making quick connections. The mud gun is mounted in a "holster" on the side of the unit so that it is ready for quick action.

The mud pump is spotted beside the suction pit or tank and the suction line hooked up. A connection is also made from the suction line to the fresh water line. The outlet lines are then connected so that water can be pumped through the connection on the middle of the skid or switched to the front corner of the skid when mud is being pumped. When it is desired to mix mud, the steel hose is disconnected from the line running to the rig and hooked into the jet gun mounted on the side of the skid base, and the mud is jetted back into the suction pit.

## Make Rack for Wrenches From Heavy Sheet Metal

Being able to move your tools to where the work is saves time and effort in any business. This is especially true around a drilling rig when

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the location of maintenance and repair work varies, and conditions make keeping tools clean difficult.

The accompanying photograph illustrates one method of making wrenches available on a portable rack. The face of this rack is made of sheet steel heavy enough to take a beating and light enough to be movable. It is mounted on a square, pipe frame with a single, hinged leg supporting it in the back. When it is being transported, the leg is folded against the face plate, making it easily handled and reducing its space requirement.

The front of the rack is fitted with hooks for wrenches and tools that can be hooked in place. Short pieces of 1-inch pipe, plugged at the bottom and welded to the plate, accommodate others as shown.

The construction of a rack of this type is simple and inexpensive. Its size and fittings can be varied for almost any type wrench or tool. Expanded metal can replace the steel plate to make it lighter. With a little ingenuity it can be made to fit your situation and make your tools easy to get to and no trouble to replace.

## Gasoline Pump Simplifies Oil Transfer to Truck

The problem of loading a tank truck with oil from storage tanks has been simplified by one operator employing an auxiliary pump. In some cases, tank trucks are not equipped with adequate pump power to move the crude from the storage tank into the tank truck. Horsepower requirements may not be sufficient to overcome the lifting head necessary to pump oil from the point of delivery by gravity to the elevated position necessitated by the height of the tank truck.

The method in the picture employed a gasoline powered pump that was set near the connection for the truck making the run. Oil flowed from the field tank battery by gravity to the gasoline powered pump; the pump is connected to the "L"-shaped pipe, elevated vertically 6 feet or more and extended horizontally 3 or 4 feet. A valve and flexible hose connection is provided at the end of the "L"-shaped pipe. When oil moves by gravity flow from the battery to the pump, it is then easily pumped through the elevated pipe, valve and flexible hose to the tank truck inlet connection.

A small pump is normally adequate to lift the fluid this short distance. When the pump is not used for this purpose, it can be usefully employed elsewhere on the lease for auxiliary needs.


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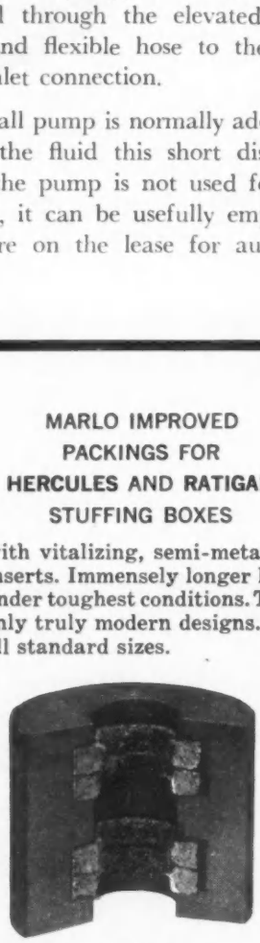

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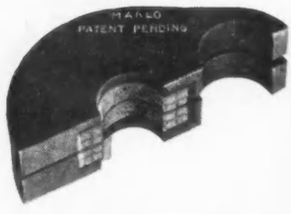


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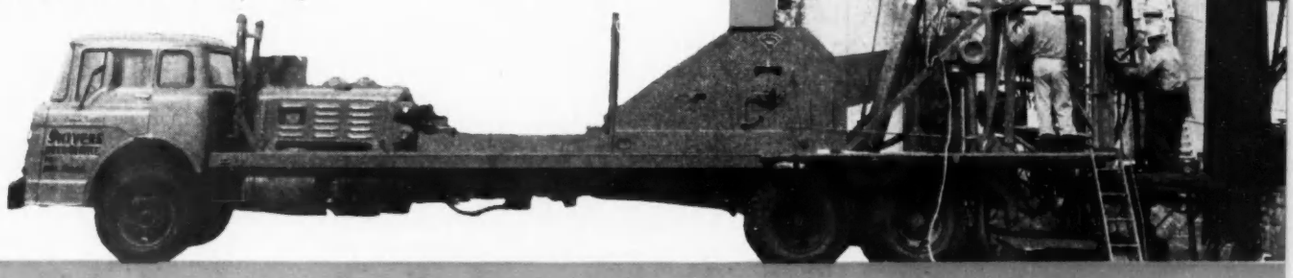

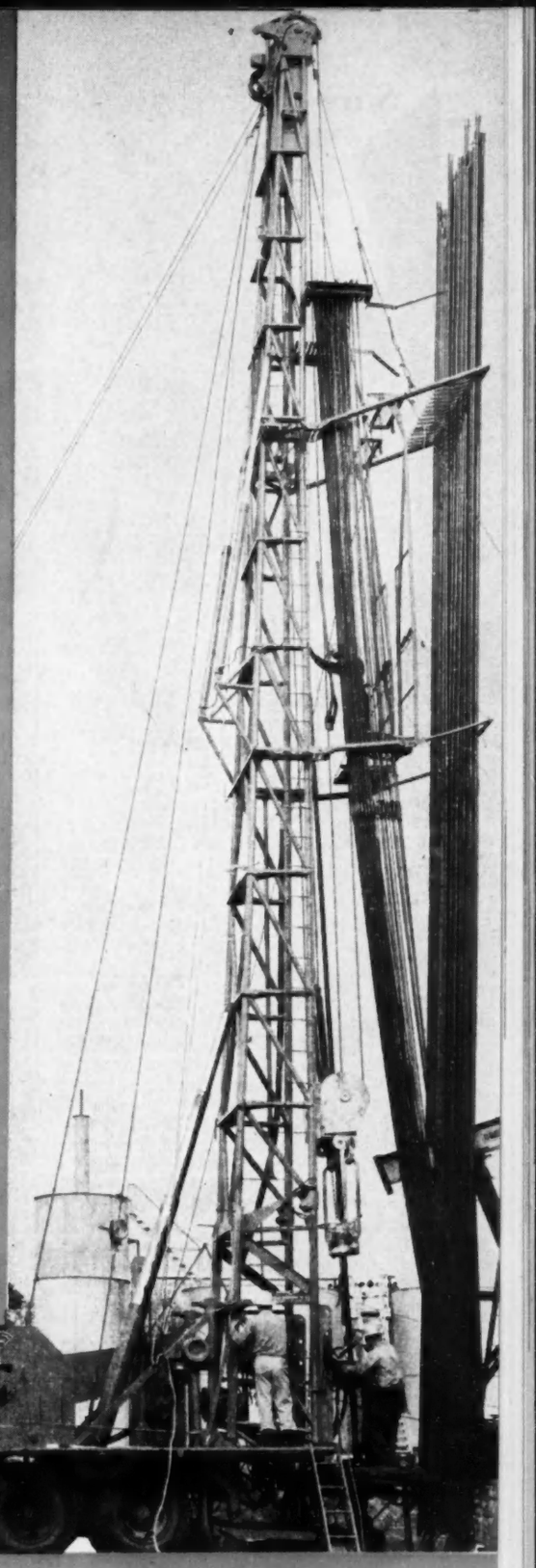

Cooper "T" Model Single Drum Workover Rig with Cooper Skytop Doubles Derrick on a deep workover job located on the Gulf Coast.

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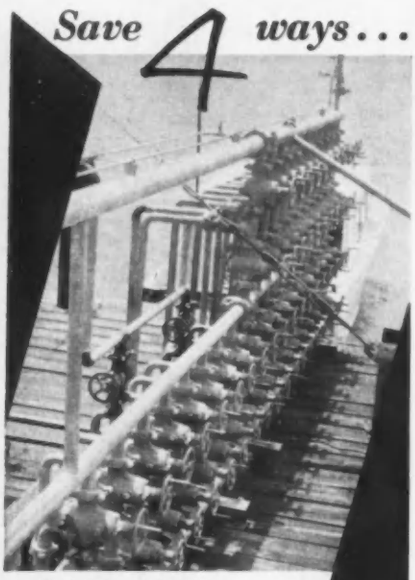


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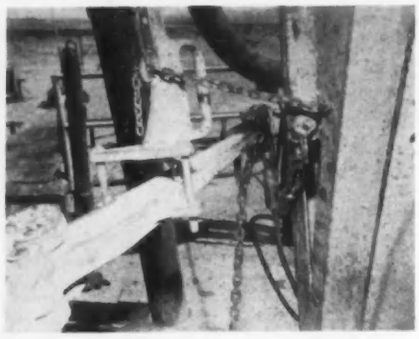

## Pipe Tongs Held Back With Hook and Chain

A simple connection for holding the tongs back out of place may be made by welding a hook to the front of the tong carrier as shown. A matching chain is then fastened to the corner of the derrick, and when the tongs are not in use, they are swung out of the way and hooked into the chain.

The eye is first cut off the hook and is tack welded to the front of the handhold where the tongs are counterbalanced. The chain is fastened by taking one of the links and cutting it in half and welding the end to the corner leg of the derrick. Then when the tongs are swung out of position, the hook facing upwards can be fitted with any link of the chain which becomes handy. This beats trying to engage a hook on a line from the corner leg.

## Supply Gas Obtained From Wellhead Stinger

Many methods of obtaining clean supply gas for pneumatic valves at well locations are in use today. One simple, economical method applicable in many areas is illustrated above.

The well shown is being produced on time cycle control. It is essential that clean supply gas be obtained to prevent fouling of the intermitter pilot. A 2-inch piece of pipe approximately 6 feet long is screwed into the wellhead. This stinger acts as a reservoir for gas breaking out of solution from the oil or condensate produced. The reservoir is provided with a 2-inch bull plug tapped ½-inch on the upper end. A ½-inch needle valve and sufficient copper tubing is provided to relay the gas to the intermitter supply gas regulators.

The stinger is especially useful on wells which are equipped with packers since gas cannot be obtained from the casing.

## Old Drum Is Converted Into Chemical Mixing Tank

A tank for mixing quebracho, caustic soda and other powdered chemicals may be made by putting paddles into an old steel drum as shown. The top is first cut out and the rough edges pounded down to make a smooth rim. The paddles are welded to a piece of ½-inch rod which is bent to form a crank on one end and cut square on the other. The plain end is set down into a ¾-inch nipple welded into the center of the bottom of the drum.

Ears are welded to the side of the top and holes cut into them so that the bar which goes across the top can be adjusted to give clearance to the paddles. After the bar is bolted firmly in place, the crank turns easily to mix the chemicals with water.

A connection on the bottom of the drum with a valve for bleeding the mixture into the mud ditch completes the assembly. The tank is then mounted on top of the mud ditch at a convenient place so that the chemicals can be easily added to the mud.

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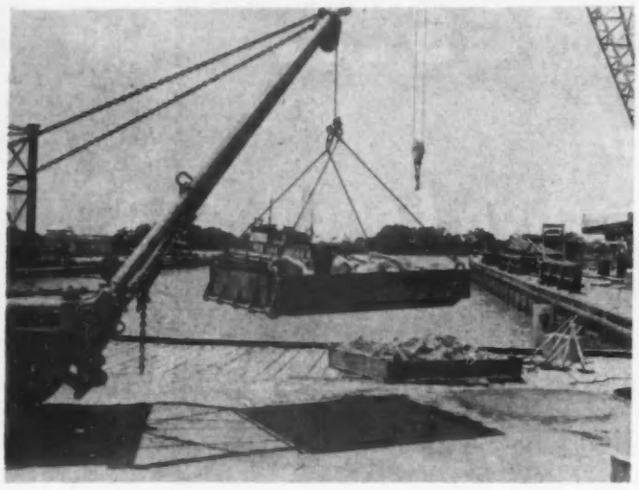

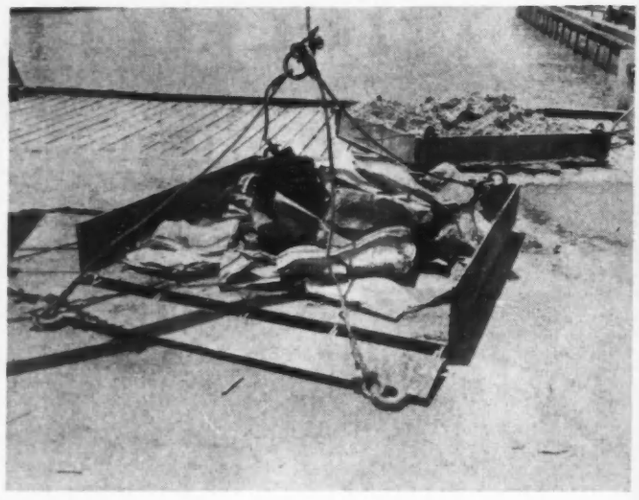

## Tray or Skip Box Makes Convenient Loading Device

A handy loading device winched behind a gang truck can be used to advantage in most loading—unloading operations around a dock or in the field.

The metal box, made of ½-inch steel, is approximately 5 feet square with one end serving as an automatic tail-gate. When lowered to platform or ground level, slack on the winch cable opens the gate eliminating lifting in loading and unloading heavy materials or drums.

The tray was handy in this case to carry sand and cement to fill a sump hole shown in the picture. The tray is a useful item when moving fuel, lubricants, chemical drums or other types of heavy, bulky material. Several drums can be handled in a vertical position. Loading and unloading hazards are eliminated and time is saved by use of the device.

The sling is made of two cables attached to each corner of the tray. The winch line is connected to the sling through the steel rings shown. This type of arrangement also adds to the versatility of the assembly.


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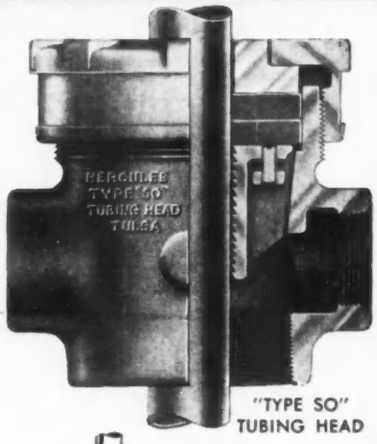
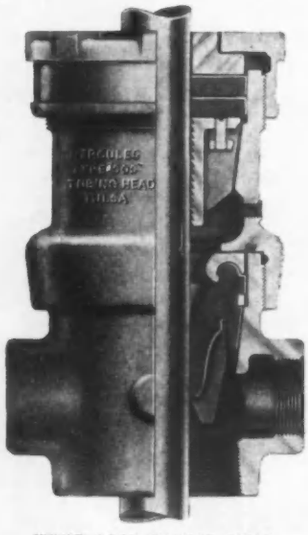
**HERCULES "Type SO" Tubing Head** is particularly suited for pumping due to compactness (only 12½" high). Stripper rubber can be used in body for running or wiping tubing. Also ideal for intermittently flowing wells.



"TYPE SO" TUBING HEAD

HERCULES "Type SO" and "SOS" Tubing Heads are the favorite of successful operators because of their simplicity, ruggedness and ease of operation. Available in 4½" OD to 7" OD Casing Sizes to suspend 2", 2½" or 3" tubing. Constructed from pressure cast steel and tested to 4,000 PSI. Slips are hinged for ease of installation and positive alignment.

**HERCULES "Type SOS" Stripper Tubing Head** is unsurpassed for use in well servicing operations as well as on flowing wells. It consists of a HERCULES "Type SO" Tubing Head with a bowl and Neoprene Tubing Stripper.



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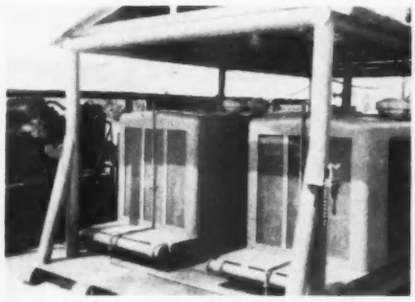


## Handy Pipe Vise on Skid Lessens Rig Work Load

When a pipe vise is needed around this rig, there's no question about where it is. Welded to the uprights on the generator skid this simple unit gets lots of use.

The vise is bolted to a steel plate on one upright while the support, cut out of steel plate, is welded to the second upright. In this position the vise is always ready for use and is still not in anyone's way when it is idle. For simplicity this arrangement is hard to beat, and a less expensive method is nearly impossible.

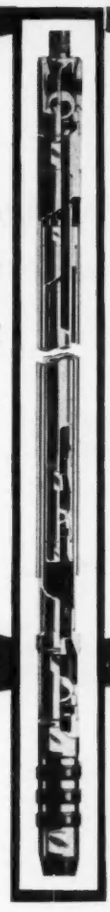
## Adjust Gun Barrel Siphon Simply and Economically

This gun barrel siphon can be easily adjusted by means of the hand operated winch illustrated. The installation is simple and economical.

The siphon is constructed of 3-inch pipe with a full swing at the bottom. A piece of 3-inch pipe is erected vertically and concreted in place. This vertical length of pipe is equipped with a pulley on top and the hand operated winch toward the bottom.

By manipulating the winch and locking it in position, the siphon can be maintained in any desired position to control the water level in the gun barrel. The assembly eliminates a third leg or manhandling the siphon.


FOR FAST PUMPING



BUT EASY ON THE RODS

The H-F 3-Tube Rod Pump consists of two concentric, loose-fitting tubes (plunger and jacket tube) that telescope over and in a third, stationary tube which serves as the pump barrel. In operation, fluid is circulated in the annular space between the outer tube and the standing barrel which packs off and compensates for the loose plunger fit. This "fluid seal" design allows the plunger to fall freely so that the pump can be operated at the optimum pumping rate — even if a fast rate is desired — and yet be easy on the rods. The loose-fitting plunger and small plunger bore afford a number of other operating advantages, such as a higher fluid discharge velocity, keeping float sand in suspension, reducing failures due to excessive rod stretch, reducing plunger friction and abnormal wear of working parts, and preventing the plunger from sticking or galling due to sand or abrasion in the fluid. H-F 3-Tube Rod Pumps, with standard A.P.I. balls and seats, are available in 2" x 1¼", 2½" x 1¾", and 4" x 3¼", sizes in 12' to 25' lengths from leading stores throughout the oil patch. Either regular or on-and-off types can be furnished. Ask your store, or one of our representatives, for illustrated literature, or write P. O. Box 127, Fort Worth.

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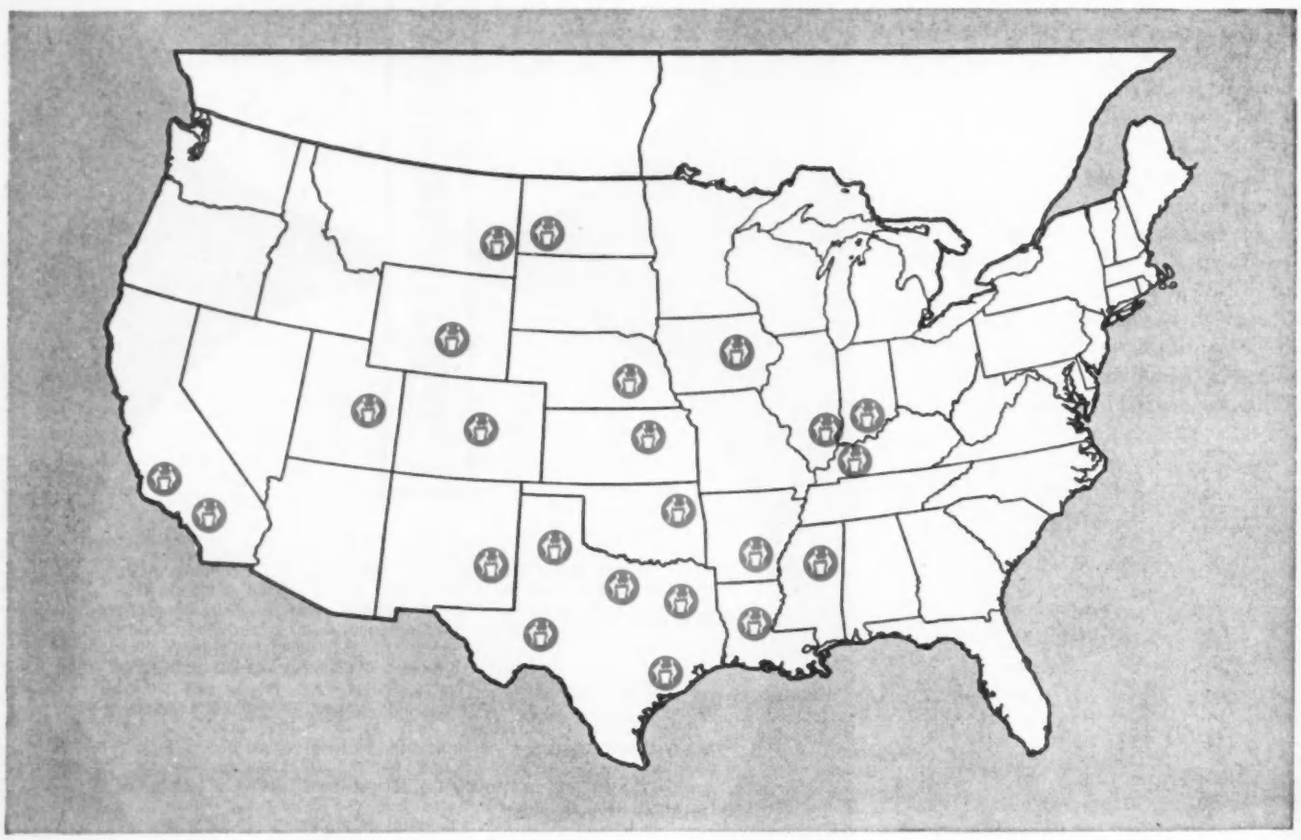

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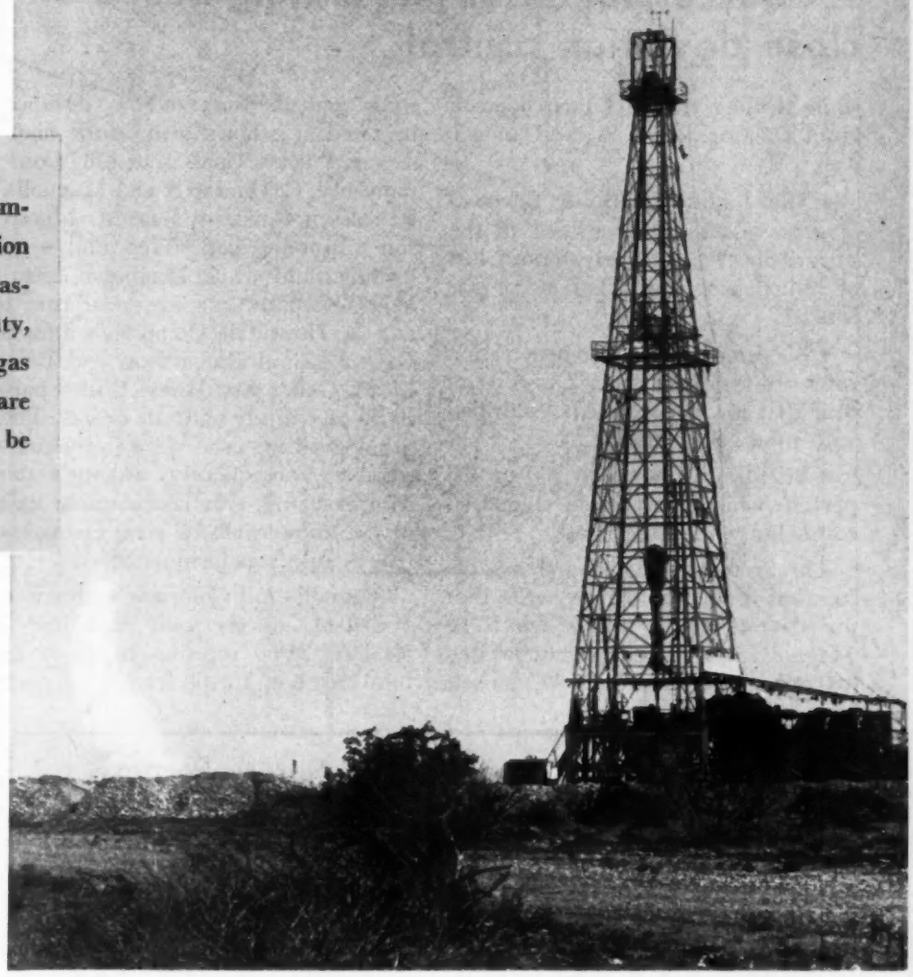


Magnolia Petroleum Company Rig 28 on location drilling the Brown & Bassett 1 in Terrell County, Texas. Magnolia is using gas as the drilling fluid. Flare from return flow can be seen at the left.

*These results show importance of . . .*

# Air and gas drilling as cost-cutters

**The industry is aware of the necessity for improving present drilling operations. Here is an area where new drilling practices are paying dividends.**

**By Jack F. Earl,** WORLD OIL Staff

AIR AND GAS DRILLING are stimulating interest in Terrell County, Texas.

Several oil operators have successfully drilled wells to 15,000 feet which heretofore were considered an economical burden on their planned budget.

This area has presented severe hole deviation conditions, slow penetration rates, and loss of circulation problems. However, with the introduction of air and gas drilling in this area, several of these problems have been alleviated or eliminated. Operators were also faced with the rugged terrain for making well locations and adequate accommodations for the operating personnel.

Just what has been learned through the use of air or gas in Terrell County?

Magnolia Petroleum Company, Richardson & Bass Oil Company, Hunt Oil Company, and Texas Pacific Coal & Oil Company are actively engaged in drilling operations in this area. From their operations, the following conclusions were observed:

- Where there is not an excess of formation water, air and gas drilling far surpasses that of mud drilling.

- To combat hole deviation conditions, whether drilling with mud, air or gas, it is necessary to design the bottom-hole assembly properly.

- Presence of small amounts of water does not necessarily impede the use of air or gas. This was observed

## . . . Successful air or gas drilling based on close deviation control

while drilling the 12¼-inch hole on Hunt Oil Company's Buster Canon 1 well.

- The highly fractured Edwards lime zones which are drilled in the surface holes create very serious loss of return problems unless air or gas is used.
- By using air or gas, penetration rates are improved from 2 to 6 times over that of comparative holes drilled with muds. See Table 1.
- Bit life was increased 300 to 400 percent while using gas as compared to bit life while using mud.

The accompanying map shows the location of five of the six wells that are discussed in this article. The Magnolia Morrison 1 well is located 18 miles east of Brown & Bassett wells and, because of the distance involved, it is not shown on the map. Texas Pacific Coal and Oil Company's W. C. Dunlap A and Magnolia Petroleum Company's L. M. Morrison 1 were drilled using mud as a drilling fluid while Magnolia Petroleum Company's Brown and Basset 1 and 2, Hunt Oil Company's Buster Canon 1, and Richardson and Bass' M. H. Goode Est. 1 were drilled partially or entirely with air or gas. The lithological intervals were fairly comparable; consequently, although the Morrison well was considerably east of the above wells, a good comparative picture was formulated.

Magnolia Oil Company's Morrison 1 drilled entirely with mud had a total of 2,860 rotating hours to its total depth of 15,168 feet. A 5½-inch casing string was set into the Ellenberger formation.

In view of the expanding success that has been received through the use of air and gas in other areas of operations, Magnolia personnel recommended the Brown & Bassett 1 be drilled with air and gas.

A 12¼-inch hole was drilled, then reamed to 17½ inches to 882 feet with air rather than gas because of possible contamination of the ground waters. Small amounts of water were encountered at 620 feet. Continuous injection of water was necessary to proceed with air drilling through the interval of 620-882 feet. Six 520 cubic feet-per-minute compressors were used. At 882 feet, a 13⅜-inch casing string was set and cemented.

A 12¼-inch hole was drilled with calcium base mud to 6,326 feet. A 9⅝-inch intermediate casing string was set and cemented in two stages.

Magnolia commenced drilling with gas out from under the 9⅝-inch casing. Gas for engines and drilling fluid was supplied from two nearby wells. Permission was granted by the Railroad Commission to use 2.5 MMcfpd and to flare the returned gas. Eight hours were required to unload the fluid for gas drilling. The surface pressure at this depth was 100 pounds per square inch, while during the coring operation pressures were 175 psi. At 12,406 feet, a high-pressure gas interval was encountered in the Silurian formation resulting in a costly blowout and fire which partially destroyed the company's drilling rig.

After killing the blowout, Magnolia moved in another rig, and drilled ahead to 13,157 feet. A 7⅝-inch casing string was then landed and cemented.

Although the fire was a costly incident, Magnolia again returned to drilling with gas. The mud was displaced in a single stage operation—water-water with gas with a surface pressure of 1,150 psi. The gas flowed into the well until the pressure of 1,150 psi was exceeded. Then a solution of water and DME (foaming agent) was pumped into the well until the circulation pressure fell below the line pressure. This operation continued until gas could be injected continuously and smoothly.

The well then was drilled to 14,159 feet with gas. A gas flow at this depth required mudding up. This method

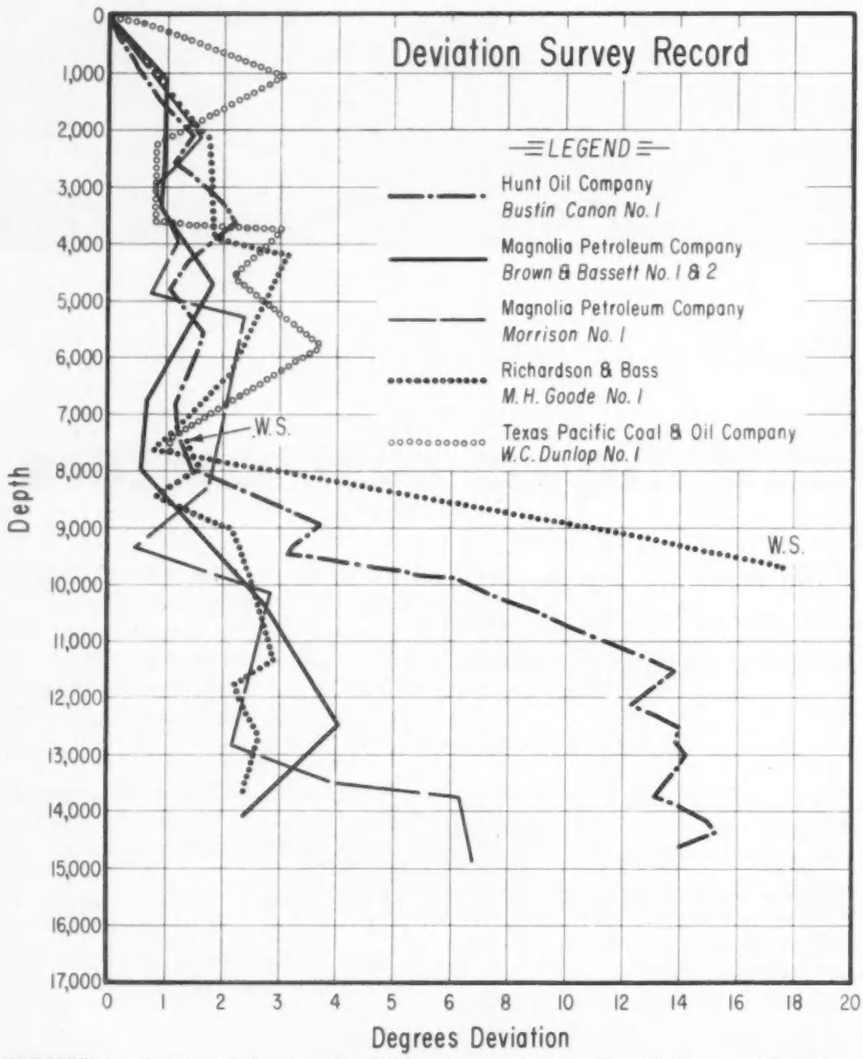



**FIGURE 1—Crooked hole characteristics are prevalent in Terrell County. The above graph shows the deviation record of five wells that have been or are drilling in this area.**

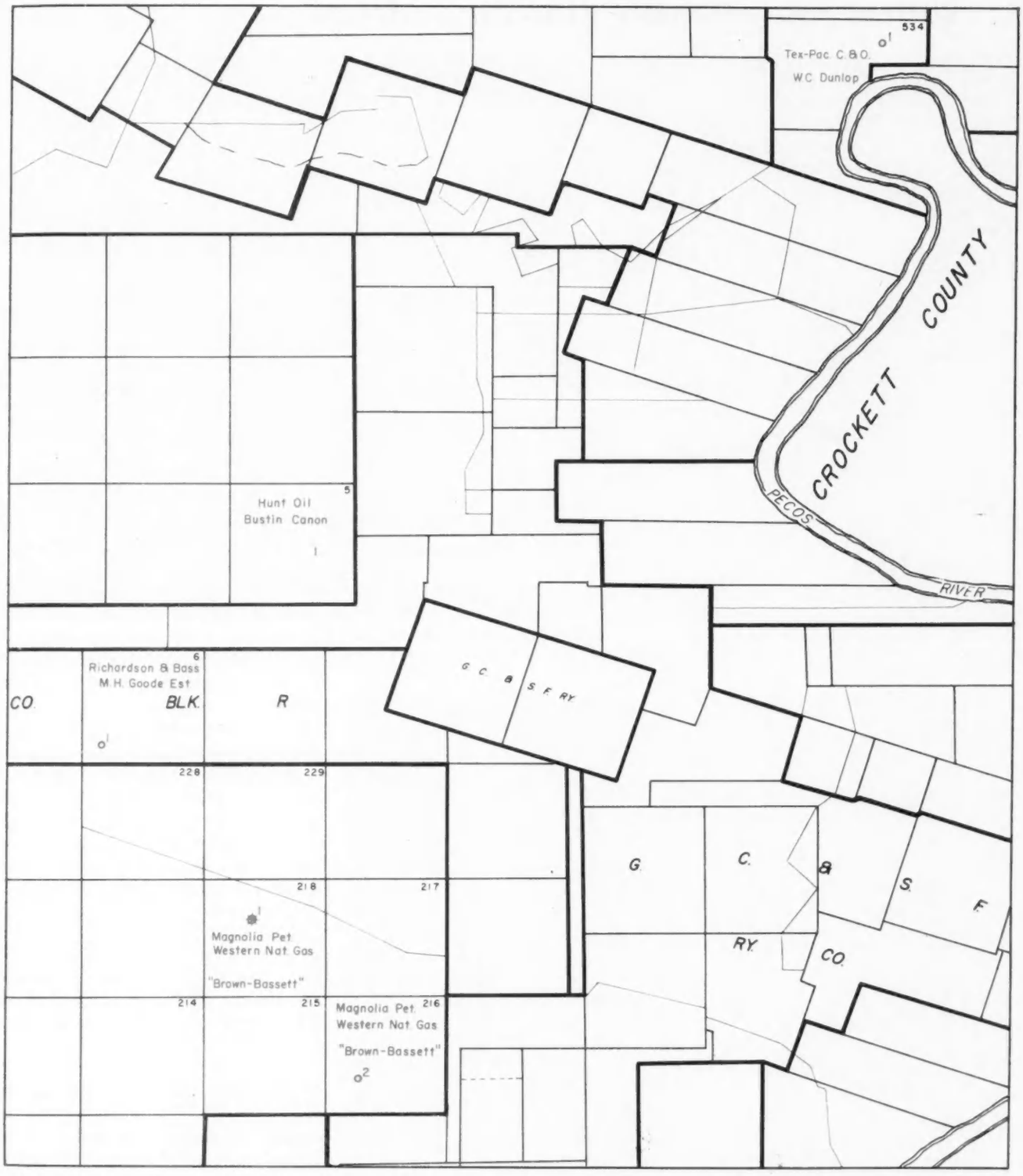



**FIGURE 2—Map of a portion of Terrell County, Texas showing the wells that were drilled entirely or partially with air or gas.**

of drilling was used to the total depth of 15,556 feet where a 5-inch liner was set and cemented. The well then was perforated and completed through perforations 13,775-13,780 feet.

Since Magnolia succeeded with its air and gas venture in this area, it was recommended that with further drilling, wherever possible, air or gas should be used as the drilling fluid.

In view of this recommendation, the drilling prognosis of their Brown & Bassett 2 well was designed for the use of gas. The gas was supplied from their Well 1. The surface hole was drilled with air instead of gas. No formation water was encountered in the 12¼ or 8⅝-inch hole of the Brown & Bassett 2 well; consequently, they were able to maintain gas drilling operations to 12,514 feet. At this depth the well was mudded up to drill through the Fusselman zone, where gas was expected. At 12,898 feet, a 7⅝-inch casing string was run. The casing was stuck at 12,103 feet, thus necessitating cementing it in place at this depth. From this depth, a 6⅝-inch hole was mud drilled to 14,300

## . . . Bottom hole assembly of top importance

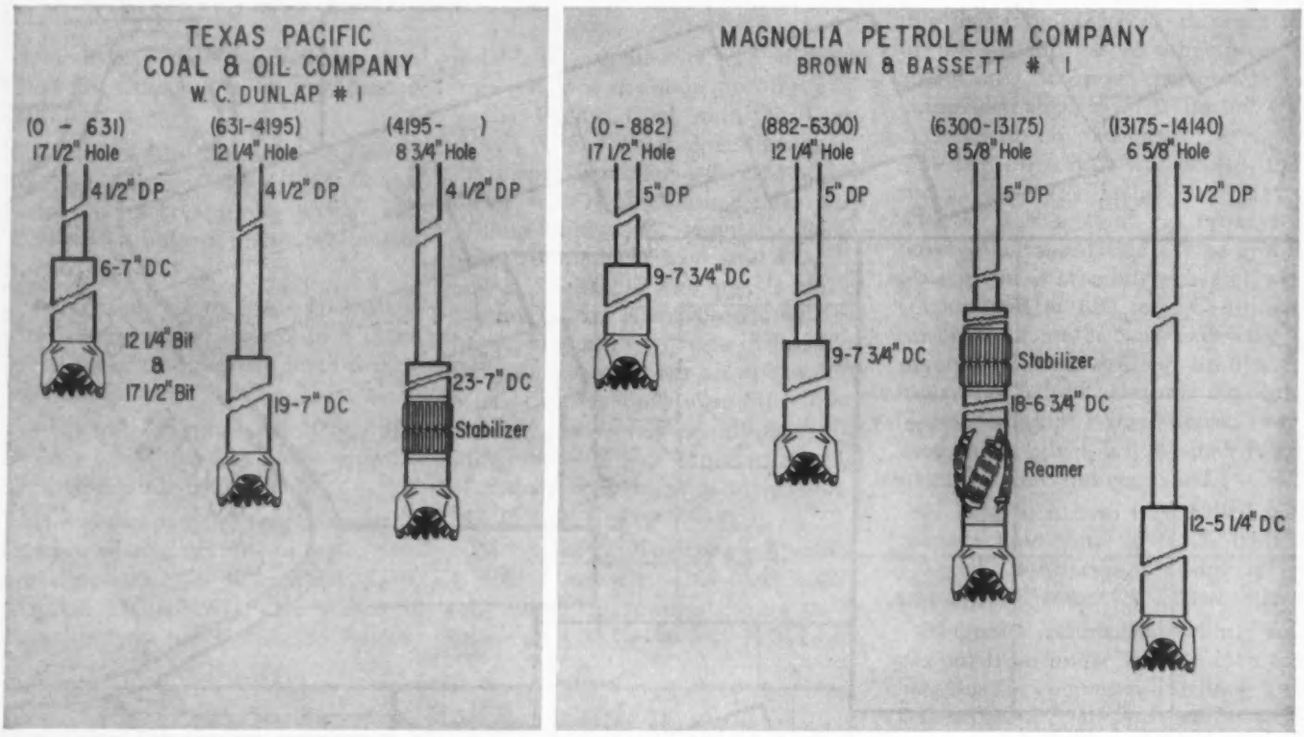
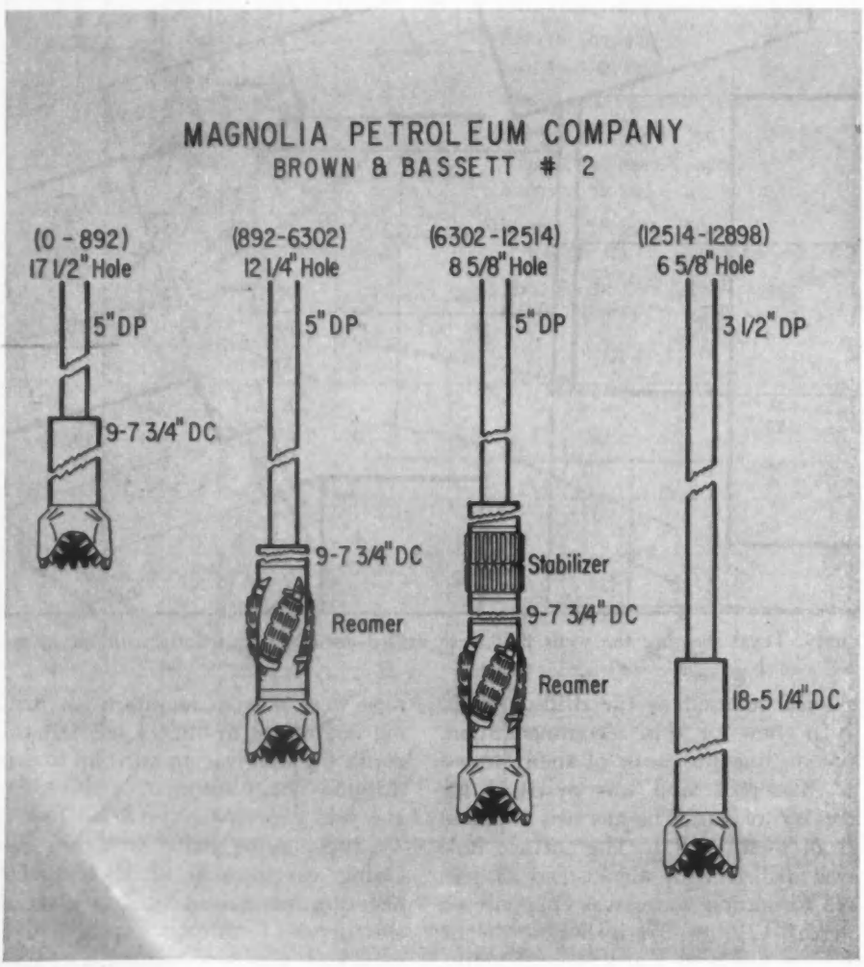



**FIGURE 3—Bottom hole assemblies are of great importance in combating crooked hole conditions. The diagrams on this and the following page show the assemblies that were used on the respective wells.**

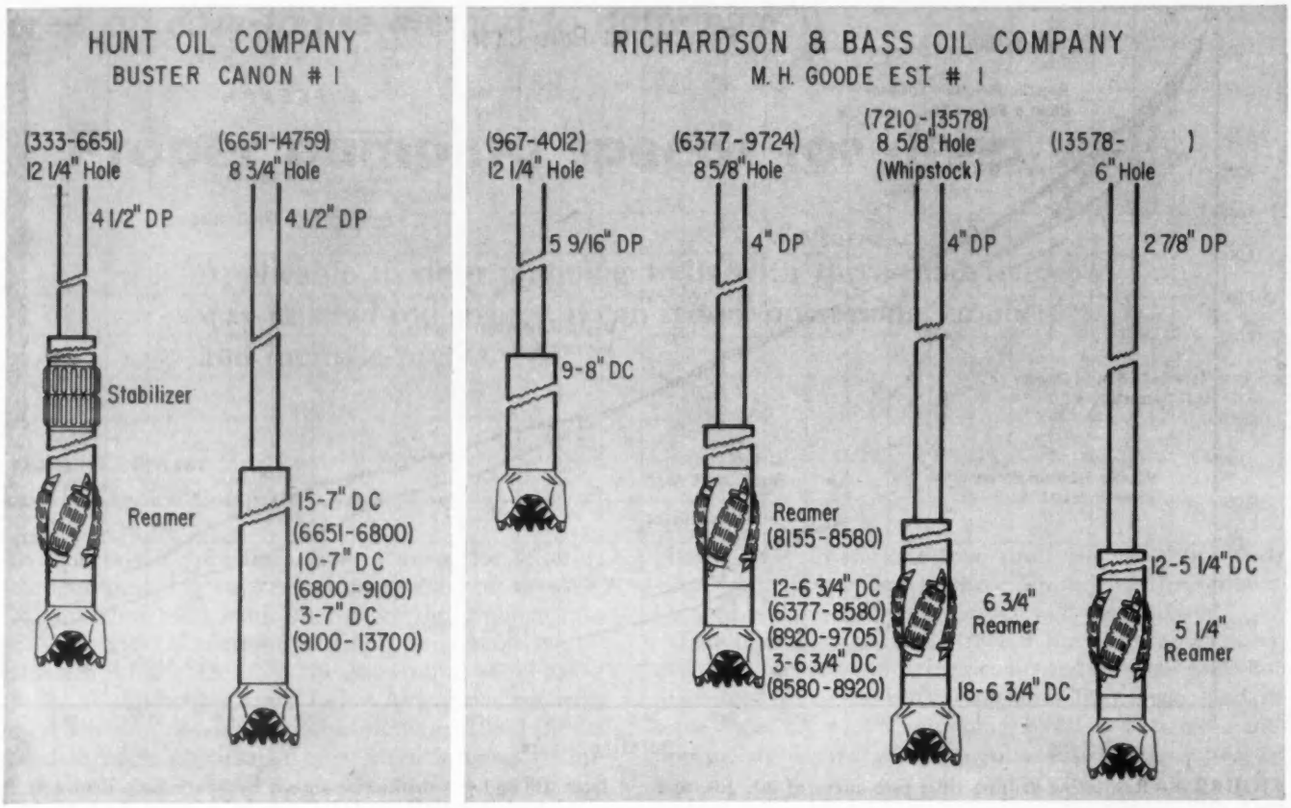



feet. A 5-inch liner was set, and a 4¾-inch hole was drilled out from under it. Throughout the entire drilling operations, no unusual deviation problems existed.

Hunt Oil Company drilled its Buster Canon 1 well to 14,759 feet, using air except for the intervals 5,700 to 6,648 feet. Six 520 cubic foot-per-minute compressors were used. A 12¼-inch hole was drilled, then reamed to 17½-inch. A 13⅜-inch surface casing string was landed at this depth, and a 12¼-inch hole was drilled to 6,648 feet. Through the interval 1,700 to 1,800 feet, a water bearing formation was encountered.

However, by using the "mist" drilling technique, air drilling was continued. This technique utilizes the mixing of lime water and foaming agents with the air while being pumped into the well. At 5,700 feet, formation water became too great for even mist drilling, and it was necessary to drill the remaining 12¼-inch hole with mud. A 9⅝-inch casing was landed at 6,648 feet.

From here to total depth, air again was used. Good penetration rates were obtained to approximately 8,300 feet. Crooked hole conditions were severe from this depth to 14,759 feet, and the hole deviated from 3 degrees




at 8,300 feet to 14 degrees at 14,759 feet. Several doglegs developed in the hole causing the pipe to stick, resulting in abandonment of the well.

Richardson & Bass Oil Company drilled its M. H. Goode Est. 1 just west and north of Magnolia Petroleum Company's Brown and Bassett 1. The 17½-inch surface hole and 12¼-inch intermediate hole to 3,876 feet were drilled with air utilizing six air compressors. At this depth, encroachment of formation water was too great to continue air drilling and it was necessary to mud up.

Drilling with mud continued to 6,349 feet, where 9⅝-inch casing was set. Through the interval of 6,377 to 9,705 feet, air again was used. At 9,705 feet, severe deviation problems were encountered. The deviation increased from 4½ degrees at 8,600 feet to 18 degrees at 9,724 feet, requiring the setting of a whipstock. The whipstock was set at 7,206 feet and mud drilling operations were commenced and continued to the present depth of 13,850 feet. No unusual deviation again occurred. This interval showed the economical importance of gas drilling versus mud drilling. See Table 1.

Texas Pacific Coal & Oil Company is presently drilling its W. C. Dunlap A with drilling mud and, because of its proximity to the other wells, it is being used for comparison purposes. Since the original drilling program was designed to drill to a lesser depth than the present objective, it was felt that the added air or gas expenditures could not be justified. However, in view of the successful air and gas operations, the company plans to use gas as its drilling medium for future drilling operations. Texas Pacific Coal & Oil Company was drilling ahead in early August.

**How good is air and gas drilling?**

Table 1 shows the tabulation of respective intervals that were drilled with air, gas or mud on six different wells. Magnolia's Brown & Bassett 2 well, which was drilled with gas from 992 to 12,514 feet, showed the best performance. In comparing the Brown & Bassett 2's 12¼-inch hole with that of its Morrison 1, a mud drilled hole, an improvement in the footage

**These figures show dollar-and-cents importance of air-gas drilled wells in these cases**

**TABLE 1**

| | Method of Drilling | Interval | Size of Hole | Footage | No. of Bits | Footage/ Bits | Percent Improvement | Rotating Hours | Ft./Hr. | Percent Improvement |
|---|---|---|---|---|---|---|---|---|---|---|
| Brown-Bassett 1 | M | 882– 6,326 | 12¼ | 5,444 | 53 | 103 | 24.0 | 680 | 8 | 2.0 |
| Brown-Bassett 2 | G | 992– 6,302 | 12¼ | 5,310 | 13 | 408 | 393.0 | 350 | 13 | 71.0 |
| Bustin Cannon 1 | A | 950– 6,651 | 12¼ | 5,701 | 18 | 317 | 281.0 | 470 | 12 | 58.0 |
| M. H. Goode Est. 1 | A & M | 974– 6,350 | 12¼ | 5,376 | 34 | 158 | 88.0 | 530 | 10 | 32.0 |
| W. C. Dunlap 1 | M | 1,060– 6,660 | 12¼ | 5,600 | 36 | 155 | 87.0 | 600 | 9.3 | 23.0 |
| Morrison 1 | M | 670– 6,567 | 12¼<br>8¾ | 5,897 | 71 | 83 | 0.0 | 770 | 7.6 | 0.0 |
| Brown-Bassett 1 | A & M | 6,326–13,175 | 8⅝ | 6,849 | 18 | 380 | 930.0 | 349 | 19.5 | 473.0 |
| Brown-Bassett 2 | G | 6,362–12,514 | 8⅝ | 6,252 | 14 | 447 | 1,100.0 | 509 | 12.3 | 265.0 |
| Bustin Cannon 1 | A | 6,651–14,759 | 8¾ | 8,108 | 22 | 368 | 895.0 | 650 | 12.5 | 268.0 |
| M. H. Goode Est. 1 | M | 7,230–13,578 | 8⅝ | 6,348 | 171 | 37 | 0.0 | 1,839 | 3.4 | 0 |
| Morrison 1 | M | 6,370–13,130 | 8¾ | 6,760 | 144 | 47 | 27.0 | 1,533 | 4.4 | 29.0 |

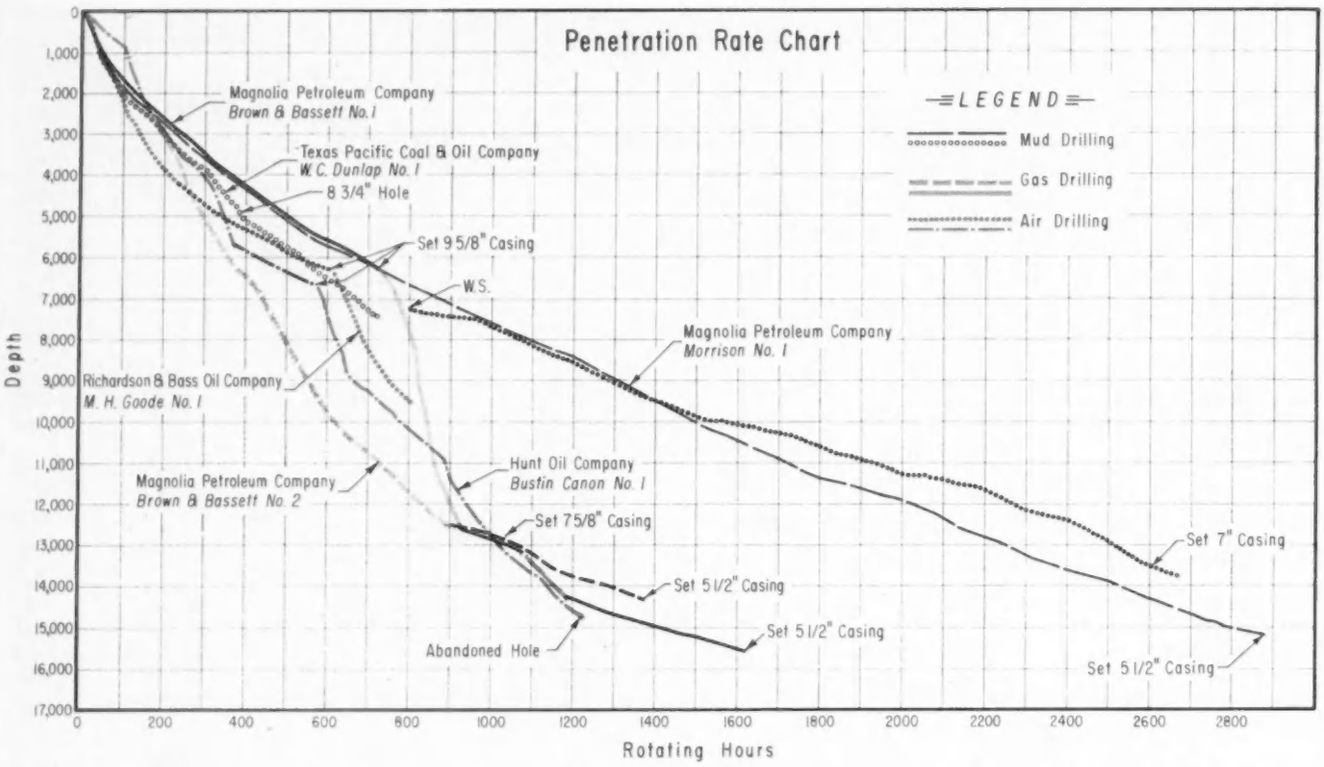



**FIGURE 4—Respective drilling time rate curve of air, gas, and mud drilled wells. Phenomenal drilling results were received from air and gas drilling as shown by Magnolia's Brown & Bassett 1 and 2, and Hunt Oil Company's Canon 1.**

per bit was observed at 408 percent and the penetration rate showed an improvement of 71 percent.

Hunt Oil Company's Buster Canon 1 fell short of the Brown & Bassett 1 performance. However, relative to the Morrison well, it showed a decisive improvement of 281 percent in the footage drilled per bit and 58 percent improvement in penetration rates.

An 8⅝-inch hole was drilled with gas on Magnolia's Brown & Bassett 2 well through the interval 6,362 to 12,514 feet. This zone was compared with similar mud drilled zones in Richardson & Bass' Goode 1 well, and an improvement of 509 percent was observed in the amount of footage that was drilled per bit. See Table 1.

The other wells that were not mentioned above had intervals that were drilled with a combination of air, mud or gas. And when gas or air was used, considerable savings were observed.

**Bottom-hole assembly.** Proper designing of bottom-hole assemblies is of great importance in combating crooked hole areas. Figure 5 is a schematic diagram of the respective assemblies run on each well. Although bit weights are generally low, 10-15,000 pounds, while drilling with air or gas it also is essential that a rigid bottom-hole assembly be used. If crooked hole conditions are anticipated, whether it will be drilled with air, gas or mud, it is best to equip the drilling string with an assembly to lessen the amount of deviation.

Certain intervals are prone to deviate no matter how cautious operators are; however, with the proper stabilization program, it is possible to minimize or eliminate doglegging characteristics. A hole with a gradual increase in deviating can be tolerated.

Several articles have been published relative to combating crooked hole conditions, such as stabilizing the drilling string with rubber stabilizers, 3 or 6 point string or bottom-hole reamers, enlarged drill collars, lower bit weight, and faster rotary rpm. These all are proven remedies and have shown their merit in Terrell County. —**The End**

**These major lessons were learned from air and gas drilling in Terrell County:**

1. **Unloading the hole in a single stage operation at great depths is possible and economical.**
2. **Importance of insert type of rock bits.**
3. **Holes will deviate with air unless proper stabilization program is initiated.**
4. **Mist drilling technique is successful in air drilling operation where small amounts of water are encountered.**

*Here's an easy-to-use method to determine*

# Proper pumping speeds for deep wells

**Applicable to deep pumping wells with three- and four-way tapered rod strings, it can reduce operational troubles and increase profits.**

**By Tom H. Fraser**
Continental-Emsco Company, Dallas

To FURNISH oil producers with a guide for selecting the proper pumping strokes per minute for deep wells, an attempt has been made to resolve the problem into procedures and calculations as simply as possible.

Experience has established the importance of pumping oil wells at the proper spm. Loads have been reduced, more production obtained, trouble eliminated and profits realized through application of non-synchronous pumping speeds. Most prudent operators refer to published curves and nomographs to determine proper pumping speeds (for the depth and rod string selected) when planning a pumping installation. These aids are applicable only to straight (one size) and two-taper (two sizes) rod strings. Due to these limitations, they cannot be used when considering deeper well installations.

Due to rod weight and stress, it has become necessary to install tapered rod strings composed of three different diameters of sucker rods. Four sizes have been used in some cases. A proper pumping speed is extremely important at depths which require three- and four-way tapered strings.

The following data, procedures and examples are presented as a solution to the problem of designing deep well pumping installations.

## *This terminology is used . . .*

W = Weight of rod string
ST = Stretch—total over-all
SE = Static Elongation of rod string due to rod weight
K = Spring Constant of rod string in pounds to cause 1-inch stretch
L = Length of rod string
F = Natural frequency of rod string
SK = Stretch due to concentrated load on bottom of rod string

When these factors refer to the total length, they will be designated as $K_t$, $L_t$, etc. Where they refer to a part of the total string, they will be designated as $K_1$, $K_2$, $K_3$, etc.

### About the Author

**Tom H. Fraser** has been manager of the Production Machinery department for Continental-Emsco Company for the past three years. In his 24 years for Continental-Emsco, he has worked with the Engineering department in Dallas as a warehouseman, field salesman in East Texas, a city salesman in Tulsa and Fort Worth, and a district machinery salesman and district manager in North Texas. He received a B.S. degree in mechanical engineering from Texas A. & M. College and served a three-year stint as a captain in the U. S. Marine Corps.

*Turn the page for procedures and example problem . . .*

## *Here are procedures to use . . .*

**Step 1:** The first item necessary to determine proper pumping speed is the total string elongation in inches due to rod weight alone. The SE elongation for any length of sucker rods is $\frac{L^2}{1{,}320{,}000}$. In a three way tapered string it is necessary to calculate $SE_1$, $SE_2$ and $SE_3$. ($SE_t = SE_1 + SE_2 + SE_3$). The 1,320,000 fiigure is a constant.

**Step 2:** The spring constant of each section of the rod string must be calculated. By definition, the spring constant is the concentrated load (in pounds) on the end of the rod strings that will stretch that string 1 inch. The formula for the spring constant (K) is:

$$K = \frac{\text{Weight of rods per foot} \times 660{,}000}{L}$$

The figure 660,000 is a constant. Using this formula $K_1$, $K_2$ and $K_3$ should be determined.

**Step 3:** The rod string now should be considered as hanging in the well without a pump. Since no concentrated load is applied to the bottom section of the smaller size of sucker rods (the lower portion of the string), the value of $SK_3$ is zero. This section will only stretch due to its own weight ($SE_3$).

It is apparent that the length of the smaller diameter sucker rods is hanging on the bottom of the intermediate size sucker rod string. This results in a concentrated load on the bottom of the intermediate string. This intermediate section will have stretch due to its own weight ($SE_2$) and the weight of the smaller diameter sucker rod string concentrated at the bottom. With the weight of the small diameter rod string known and having calculated the spring constant, the stretch in the intermediate section due to the weight of the bottom string can be calculated. This elongation ($SK_2$) is determined by dividing the total weight of the smaller rod string by the spring constant ($K_2$) of the intermediate string.

The next consideration is the top section (or largest diameter sucker rods) of the tapered string. Also, this could possibly be the third increased diameter rod in a four size rod string. Again it is apparent that this section has a concentrated weight imposed at the bottom. Its load is composed of the weight of the two smaller diameter rod strings.

Adding the weight of these smaller diameter rod strings ($W_2$ and $W_3$) results in the total concentrated load in pounds hanging on the bottom of the top section of rods. The total weight of the two smaller sections divided by the spring constant of the larger section, will determine the stretch ($SK_1$) in the larger section due to this concentrated weight.

**Step 4:** The total number of inches of rod stretch (ST) is the total static elongation of the string due to the actual weight of the sucker rods themselves and that due to the concentrated loading on the bottom of each rod section. The value of ST is obtained by adding $SE_t$ and $SK_t$.

**Step 5:** The natural frequency of the sucker rod string is determined by the following formula: $F = \frac{206}{\sqrt{ST}}$. This calculation provides the natural frequency of the string in vibrations per minute.

In order to be sure that a non-synchronous pumping speed has been obtained, the natural frequency is divided by the desirable pumping order (1½, 2½, 3½, 4½, etc.). This calculation will determine the proper number of spm that provides all possible benefits to be derived from pumping at a non-synchronous speed.

**Step 6:** A check should be made to be sure that the strokes per minute selected by the preceding method are not ones that would exceed the maximum allowable sucker rod stress. This calculation is as follows:

$$\text{SPM Maximum} = \frac{11{,}500 - (\text{Total Depth in feet} - 10\% \text{ of T.D.})}{4 \times \text{stroke length in inches}}$$

This formula will determine the strokes per minute at which a stress of 35,000 psi will be imposed on the rods. If a safety factor is desired, the figure 10,000 may be substituted for the constant (11,500) in the SPM Maximum formula. This figure would indicate the spm for a rod stress of 30,000 psi.

If the resulting maximum permissible strokes per minute is greater than the proper pumping speed calculated by the natural frequency method, the non-synchronous spm selected is acceptable. If it is less than the proper spm selected by the natural frequency method, a decrease of one full order or more is indicated. The decrease is required to select a speed less than that which will stress the sucker rods to their allowable limit.

**TABLE 1—Percentages for 3-Way Tapered Rod Strings**

| Plunger Diameter | 1"—⅞"—¾" | | ⅞"—¾"—⅝" | |
|---|---|---|---|---|
| | %¾" | %⅞" | %⅝" | %¾" |
| 1 1/16" | 58.5 | 22.3 | 50.5 | 26.2 |
| 1¼" | 55.4 | 23.9 | 45.7 | 28.7 |
| 1½" | 50.5 | 26.4 | 38.2 | 32.7 |
| 1¾" | 44.9 | 29.5 | 29.4 | 37.3 |
| 1 25/32" | 44.0 | 29.9 | 28.1 | 38.0 |
| 2" | 38.2 | 33.0 | 19.2 | 42.7 |
| 2¼" | 30.8 | 36.9 | 7.6 | 48.8 |

* Based on theory of equal stress at top of each step of string for static conditions.

**TABLE 2—Percentages for 4-Way Tapered Rod Strings**

| Plunger Diameter | 1⅛", 1", ⅞" & ¾" | | |
|---|---|---|---|
| | %1" | %⅞" | %¾" |
| 1 1/16" | 17.03 | 19.25 | 48.30 |
| 1¼" | 18.27 | 20.66 | 44.54 |
| 1½" | 20.23 | 22.88 | 38.57 |
| 1½" | 23.81 | 26.59 | 27.73 |
| 1¾" | 22.55 | 25.50 | 31.52 |
| 1 25/32" | 22.87 | 25.87 | 30.56 |
| 2" | 25.24 | 28.55 | 23.38 |
| 2" | 32.24 | 36.75 | 1.38 |
| 2¼" | 28.27 | 31.98 | 14.17 |
| 2½" | 31.67 | 35.83 | 3.86 |

## . . . and an example problem

In order to illustrate the preceding procedure the following conditions are assumed:

Pump Setting—9400 feet
Rod Sizes—1 inch, 7/8 inch and 3/4 inch
Plunger Size—1 1/4 inch
Polished Rod Stroke—120 inches

A non-synchronous speed must be selected for this well without exceeding the maximum allowable sucker rod stress. The method of solution is as follows:

Find $L_1$, $L_2$ and $L_3$. From Table 1:

$$\text{1-Inch Rods} - 20.7\% \times 9400 = 1950 = L_1$$
$$\text{7/8-Inch Rods} - 23.9\% \times 9400 = 2250 = L_2$$
$$\text{3/4-Inch Rods} - 55.4\% \times 9400 = 5200 = L_3$$

Determine the static elongation of each section of the rod string due to its own weight and the total static elongation of the whole string.

$$SE_1 = \frac{1950^2}{1{,}320{,}000} = \frac{3{,}800{,}000}{1{,}320{,}000} = 2.88$$

$$SE_2 = \frac{2250^2}{1{,}320{,}000} = \frac{5{,}062{,}500}{1{,}320{,}000} = 3.84$$

$$SE_3 = \frac{5200^2}{1{,}320{,}000} = \frac{27{,}040{,}000}{1{,}320{,}000} = 20.5$$

$SE_t = 20.5 + 3.84 + 2.88 = 27.22$ inches, which is the total stretch of the rod string due to its own weight.

Spring constants for each section of the rod string must be determined. Rod weights are listed in Table 3.

$$K_1 = \frac{2.88 \times 660{,}000}{1950} = \frac{1{,}900{,}800}{1950} = 975\text{\# for 1 inch}$$

$$K_2 = \frac{2.17 \times 660{,}000}{2250} = \frac{1{,}432{,}200}{2250} = 637\text{\# for 7/8 inch}$$

$$K_3 = \frac{1.62 \times 660{,}000}{5200} = \frac{1{,}069{,}200}{5200} = 206\text{\# for 3/4 inch}$$

Calculate the weight of each section of the rod string:

$$W_1 = 2.88 \times 1950 = 5620\#$$
$$W_2 = 2.17 \times 2250 = 4885\#$$
$$W_3 = 1.62 \times 5200 = 8425\#$$

The stretch due to the load concentrated at the bottom point of each section must be calculated. Since the bottom section (3/4 inch in this instance) has no concentrated load on the lower portion, it has no stretch based on $K_3$ ($SK_3 = 0$). For the remaining two sections:

$$SK_1 = \frac{8425 + 4885}{975} = \frac{13{,}310}{975} = 13.68 \text{ inches}$$

$$SK_2 = \frac{8425}{637} = 13.22 \text{ inches}$$

$$SK_t = 13.22 + 13.68 = 26.90 \text{ inches}$$

**TABLE 3—Sucker Rod Weights**

| |
|---|
| 5/8" = 1.14 #/ft. |
| 3/4" = 1.62 #/ft. |
| 7/8" = 2.17 #/ft. |
| 1" = 2.88 #/ft. |
| 1 1/8" = 3.67 #/ft. |

The total stretch of the rod string (ST) is determined by adding $SE_t$ and $SK_t$. $ST = 27.22 + 26.90 = 54.12$ inches.

To proceed, the natural frequency of the rod string must be obtained.

$$F = \frac{206}{\sqrt{54.12}} = \frac{206}{7.37} = 28$$

This F value must be divided by 2 1/2, 3 1/2, 4 1/2, etc., to determine spm. When applicable, the 2 1/2 order is the best spm from a non-synchronous standpoint.

$$SPM = \frac{28}{2.5} = 11.2$$

The 11.2 spm value must be checked to determine if it will stress the rods beyond their allowable limit. In this case, it is assumed that alloy rods are being used. A 35,000-psi stress value can be safely used for the calculation.

$$SPM \text{ max.} = \frac{11{,}500 - (9400 - 940)}{4 \times 120} = \frac{3040}{480} = 6.2$$

From the calculation, 11.2 spm would overstress the rods.

Due to the preceding result, a trial using the 4 1/2 order is indicated.

$$SPM = \frac{28}{4.5} = 6.2$$

The resultant 6.2 spm will be a non-synchronous speed and not overstress the rod string.

It is realized that many wells of this depth are being pumped at speeds well above the selected figure. However, when the job really becomes one of lifting instead of agitating, it is almost a certainty that their speed will be reduced (by equipment troubles, both surface and subsurface) to about 6 spm.

Many will wonder why fluid weight has been ignored. This factor has been the subject of many discussions. The dynamic stretch due to fluid load is transferred into stored energy which will be used at some point in the pumping cycle. Therefore, this stretch can be ignored in selecting a non-synchronous speed.

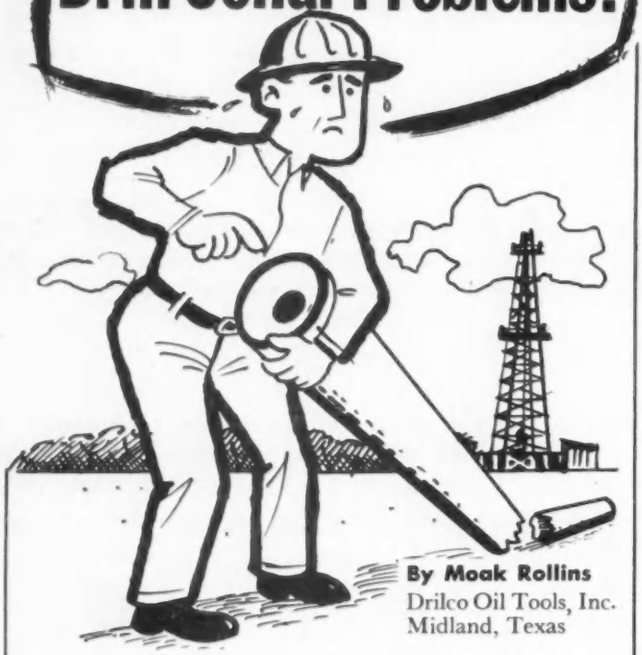
When four sizes of rods make up a rod string, one more set of calculations are added to those previously indicated. The procedure would remain as outlined.

As wells are drilled deeper, pumping problems increase. Of necessity, installations must be engineered. It is hoped that this article will stimulate and guide operators toward a profitable solution of these problems.

This method of calculating proper pumping speeds for very deep wells has been developed and checked by J. C. Slonneger. The method has been verified by field results obtained from-dynamometer analyses. —**The End**

HAVE YOU GOT

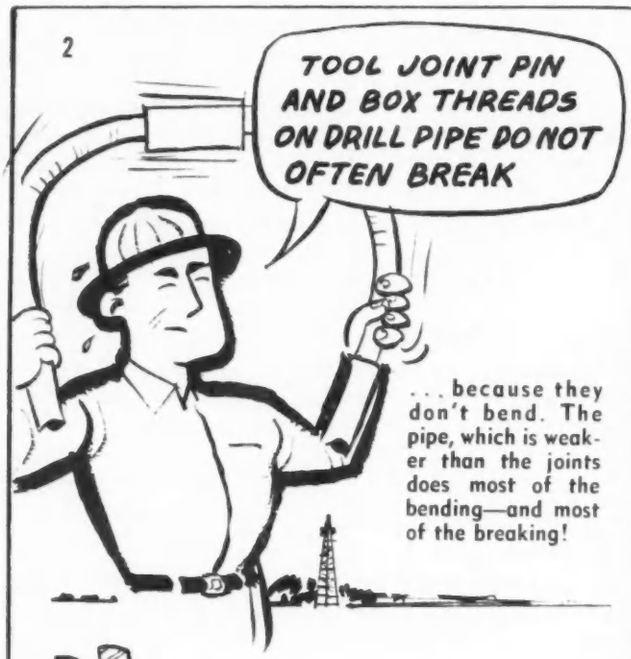
# Drill Collar Problems?



**By Moak Rollins**
Drilco Oil Tools, Inc.
Midland, Texas

This is the second of three articles explaining pictorially the most common causes of drill collar failure.

2

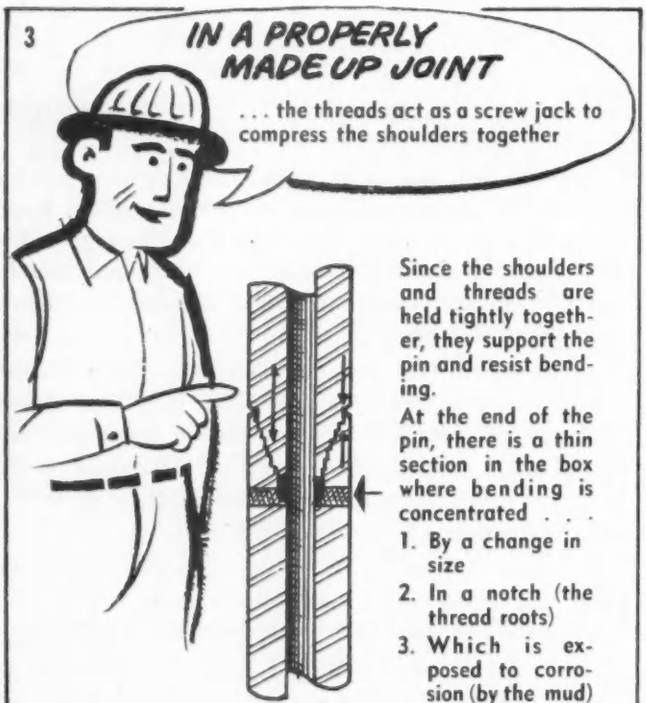



. . . because they don't bend. The pipe, which is weaker than the joints does most of the bending—and most of the breaking!

## BUT-TOOL JOINT PIN AND BOX THREADS ON DRILL COLLARS DO BREAK!

Because the collars are stronger in the body than in the joints, the joints must do most of the bending and most of the breaking.

3



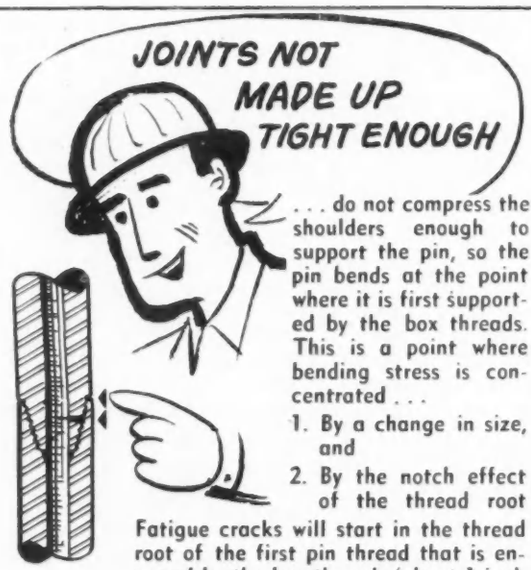

Since the shoulders and threads are held tightly together, they support the pin and resist bending.

At the end of the pin, there is a thin section in the box where bending is concentrated . . .

1. By a change in size
2. In a notch (the thread roots)
3. Which is exposed to corrosion (by the mud)

If bending is severe enough—and goes on long enough, a fatigue crack will start in the thread roots of the box at the end of the pin. The crack can progress far enough to cause a failure. Corrosion pitting of the thread roots will (1) start cracks sooner and (2) make them grow faster.

4

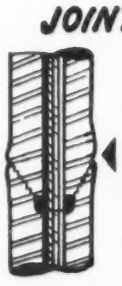



. . . do not compress the shoulders enough to support the pin, so the pin bends at the point where it is first supported by the box threads. This is a point where bending stress is concentrated . . .

1. By a change in size, and
2. By the notch effect of the thread root

Fatigue cracks will start in the thread root of the first pin thread that is engaged by the box threads (about 1 inch from the shoulder).

## JOINTS MADE UP TOO TIGHT...



. . . also cause pins to break at the same place, because the pin is stretched too far in make-up, and cannot stand additional stretching which occurs in bending the collars.

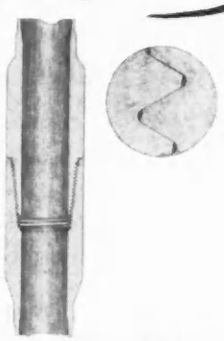
## REMEMBER!

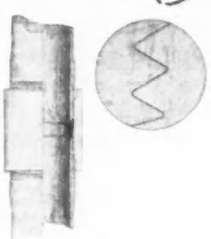
A tool joint is like a screw jack—and it is a good one. With enough pull on the tong handle, the screw jack will force the pin to break or the box to swell.

5

## TUBING AND CASING THREADS

. . . contact on crests and roots as well as on the flanks—so that the threads seal and prevent leaking of casing and tubing.





## TOOL JOINT THREADS CANNOT SEAL

. . . because they are designed to contact on the flanks only, with clearance on the crest and root.

Because the threads cannot seal, the shoulders must seal, or the tool joint will leak! Even when the collars are bending, there must be enough elastic compression in the shoulders to keep the shoulders tightly together to prevent leaking (and to support the pin). Shoulders must always be kept clean and smooth and protected from damage.

6

## LEAKING JOINTS

. . . often gall or weld together when they are unscrewed, because the metal-to-metal contact causes so much local heat.

Galls, or torn out chunks of metal, on shoulders and thread flanks are nearly always made in the unscrewing direction. Joints which have galls on shoulders or threads will be harder to make up the next time—and therefore are more likely to leak. Leaking joints can be spotted before they give severe trouble.

Look for muddy pins and for box shoulders which are not bright and shiny all over. Shoulders on leaky joints usually have dull gray areas with only two bright spots. The gray areas have been lapped by mud working in and out between the shoulders. The bright spots are the high spots which carry all of the shoulder load. During break-out, these high spots, dry of lubricant, frequently gall.

7

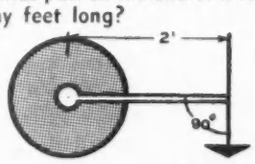
## BE SURE A JOINT IS TIGHT ENOUGH

. . . not to leak—tight enough to give shoulder support to the pin,

**BUT**—not too tight (which might break the pin).

You need to know how much twist to give the joint as you make it up. This twist is called torque—and is measured in ft-lbs. How many pounds pull on the end of a tong . . . how many feet long?

Pounds X Feet = Torque,
1,000 pounds pull on a two-foot tong arm = 2,000 ft-lbs of torque.




2,000 pounds pull on a 4-foot tong arm = 8,000 ft-lbs. The line should pull at a right angle (90-degree) to the tong arm to get the maximum torque. Use a gage to measure the line pull!

If the make-up torque is too great . . .
← The box will swell here—
— or the pin will break here.

**SO!** The make-up strength of the box is affected by the outside diameter of the collar—and the strength of the pin is affected by the inside diameter of the collar.

8

## IN THIS TABULATION

. . . the recommended torque is determined by the weaker—the pin or box.

**Recommended Make-Up Torque**

| TYPE CONN | O.D. INS. | BORE OF DRILL COLLAR—Inches 1¼ | 2 | 2¼ | 2½ | 2¾ | 3 | 3¼ |
|---|---|---|---|---|---|---|---|---|
| 3½" IF | 4¼ | 9,600 | 9,600 | 9,600 | 9,600 | 7,500 | | |
| | 5 | 14,600 | 12,400 | 11,400 | 9,600 | 7,500 | | |
| | 5⅛ | 14,600 | 13,100 | 11,400 | 9,600 | 7,500 | | |
| | 5½ | 16,000 | 14,600 | 13,000 | 11,100 | 9,100 | | |
| 3½" H90 | 4¾ | 8,900 | 8,900 | 8,900 | 8,900 | 8,900 | | |
| | 5 | 10,800 | 10,800 | 10,800 | 10,800 | 9,100 | | |
| | 5⅛ | 14,900 | 14,600 | 13,000 | 11,100 | 9,100 | | |
| | 5½ | 16,000 | 14,600 | 13,000 | 11,100 | 9,100 | | |
| 4" FH<br>4½" DSL | 5 | 8,900 | 8,800 | 8,800 | 8,800 | 8,800 | | |
| | 5⅛ | 12,900 | 12,800 | 12,800 | 12,800 | 10,600 | | |
| | 5½ | 14,100 | 14,600 | 13,000 | 12,900 | 10,600 | | |
| | 6 | 16,900 | 16,300 | 14,600 | 12,900 | 10,600 | | |
| 4" H90 | 5⅛ | | 9,900 | 9,800 | 9,800 | 9,800 | | |
| | 5½ | | 14,050 | 14,050 | 14,050 | 13,900 | | |
| | 6 | | 16,470 | 16,300 | 15,900 | 13,900 | | |
| | 6⅝ | | 19,400 | 17,800 | 15,900 | 13,900 | | |
| 4½" REG | 5½ | | 12,600 | 12,600 | 12,600 | 12,600 | | |
| | 5⅝ | | 14,100 | 14,100 | 14,100 | 14,100 | | |
| | 6 | | 16,300 | 16,300 | 16,300 | 14,100 | | |
| | 6⅝ | | 19,800 | 18,100 | 16,300 | 14,100 | | |
| 4½" FH | 5½ | | 9,900 | 9,900 | 9,900 | 9,900 | 9,900 | |
| | 5⅝ | | 14,300 | 14,300 | 14,300 | 14,300 | 14,300 | |
| | 6 | | 16,470 | 16,470 | 16,470 | 16,470 | 16,470 | |
| | 6⅝ | | 19,400 | 19,400 | 19,400 | 17,000 | 14,600 | |
| | 6¾ | | 21,400 | 20,600 | 19,000 | 17,000 | 14,600 | |
| 4½" IF<br>4" IF<br>4½" SIF | 5½ | | | 13,400 | 13,400 | 13,400 | 13,400 | |
| | 5⅝ | | | 17,800 | 17,800 | 17,800 | 17,800 | |
| | 6 | | | 20,100 | 20,100 | 18,100 | 15,800 | |
| | 6⅝ | | | 21,700 | 20,100 | 18,100 | 15,800 | |
| 4½" H90 | 5½ | | | 13,600 | 13,600 | 13,600 | 13,600 | |
| | 5⅝ | | | 17,800 | 17,800 | 17,800 | 17,800 | |
| | 6 | | | 20,100 | 20,100 | 18,400 | 16,100 | |
| | 6⅝ | | | 22,400 | 20,500 | 18,400 | 16,100 | |
| 5" H90 | 6⅝ | | | 18,700 | 18,700 | 18,700 | 18,700 | |
| | 6¾ | | | 22,400 | 22,400 | 22,400 | 20,700 | |
| | 7 | | | 25,000 | 24,500 | 22,400 | 20,700 | |
| | 7⅛ | | | 25,000 | 24,500 | 22,400 | 20,700 | |
| 5½" REG | 6⅝ | | | 22,500 | 22,500 | 22,500 | 22,500 | |
| | 6¾ | | | 28,000 | 28,000 | 26,000 | 23,900 | |
| | 7 | | | 30,000 | 28,700 | 26,000 | 23,900 | |
| | 7⅛ | | | 30,000 | 28,700 | 26,000 | 23,900 | |
| 5½" H90 | 6⅝ | | | 24,500 | 24,500 | 24,500 | 23,900 | |
| | 6¾ | | | 27,900 | 27,900 | 26,000 | 23,900 | |
| | 7 | | | 30,000 | 28,700 | 26,000 | 23,900 | |
| | 7⅛ | | | 30,000 | 28,700 | 26,000 | 23,900 | |
| 6⅝" IF<br>5" SH<br>5" SIF | 6⅝ | | | 15,300 | 15,300 | 15,300 | 15,300 | 15,300 |
| | 6¾ | | | 20,300 | 20,300 | 20,300 | 20,300 | 19,100 |
| | 7 | | | 27,900 | 27,900 | 27,900 | 21,600 | 19,100 |
| | 7⅛ | | | 27,900 | 25,900 | 23,900 | 21,600 | 19,100 |
| 5½" FH | 7 | | | | 21,500 | 21,500 | 21,500 | 21,500 |
| | 7⅛ | | | | 27,900 | 27,900 | 27,900 | 27,900 |
| | 7⅜ | | | | 34,500 | 31,500 | 29,600 | 27,800 |
| 6⅝" REG | 7⅛ | | | | 35,900 | 35,900 | 32,700 | 30,100 |
| | 7⅜ | | | | 35,900 | 35,900 | 32,700 | 30,100 |
| | 8 | | | | 35,900 | 35,900 | 32,700 | 30,100 |
| 6⅝" H90 | 7⅛ | | | | 30,100 | 30,100 | 30,100 | 27,100 |
| | 7⅜ | | | | 34,700 | 34,700 | 34,700 | 32,000 |
| | 8 | | | | 39,000 | 36,900 | 34,700 | 32,000 |

1. Torque value in foot-pounds is tong line pull in pounds multiplied by length of tong arm in feet.
2. Torque values are determined by the weakest member, pin or box. In the charts for a given connection size, torque values above stepped line are determined by box O.D. as it is weakest member of combination. Torque values below stepped line are determined by pin bore as it is the weakest member.

# Shallow production spurs Delaware Basin activity

**In Culberson County alone, 16 wildcats are now drilling after making only 13 completions during the first eight months of 1958.**

THE DELAWARE BASIN is entering the most active period in its history, with the peak at least two years away.

This optimistic report from major Delaware Basin operators is based on three factors:

**1.** Opportunities for good production from less costly, shallower Delaware sand fields.

**2.** Increased interest in deeper possibilities.

**3.** Due to fracturing methods, wells in the shallower portion of the Delaware are showing as good, if not better, initial production than the deeper fields.

At present, a large portion of the wildcatting activity is in the shallower Delaware sand areas of the basin (See map). In mid-August, at least 41 wildcats were drilling in a seven-county area, with several more staked out.

Delaware sand drilling activity has been heavy all year. During the first eight months 54 wildcats were completed from the Delaware sands, bringing in 9 producers (including four gas wells). Also, 126 field wells completed, including two gas producers, with only seven dry holes. The table on page 96 gives a county-by-county report on Delaware sand drilling activity since the first of the year.

Five new fields were discovered in Culberson and Reeves counties during the first eight months of this year, with three producing from Delaware sands. In Culberson County: Screwbean (1,000-foot sand), Screwbean (Delaware), Prewit (1,000-foot Castile sand). In Reeves County; Olds (Delaware) and Sabre (Delaware).

**Geologic features.** Except for the structural relief found in deeper southeast fields (i.e., Reeves County's Worsham field), major structural features are lacking in the Delaware Basin, thus restricting the size of the fields. The sand bodies are elongated and not too wide.

The Delaware sands outcrop in the Delaware Mountains and dip more or less uniformly to a sub-sea elevation of 5,000 feet or more at the bottom of the sand some 70 miles east of the outcrop. The Delaware Basin also has considerable deep possibilities, i.e., Devonian in Reeves County's Toyah gas field (12,500 feet to top of pay, located on very moderate Delaware structure).

Several other areas have structures comparable with Toyah and presumably are possible Devonian areas of interest. Geophysical methods will probably be important in determining deeper possibilities under Delaware structures.

Operators have found that usual geological and geophysical methods are of little use in locating Delaware sands, particularly in the shallower areas. The most practical methods are to follow good shows and study the sand conditions, or to get in between producing areas and drill. Delaware sand fields are primarily stratigraphic traps bound by permeability barriers. There are very few definite oil-water contacts.

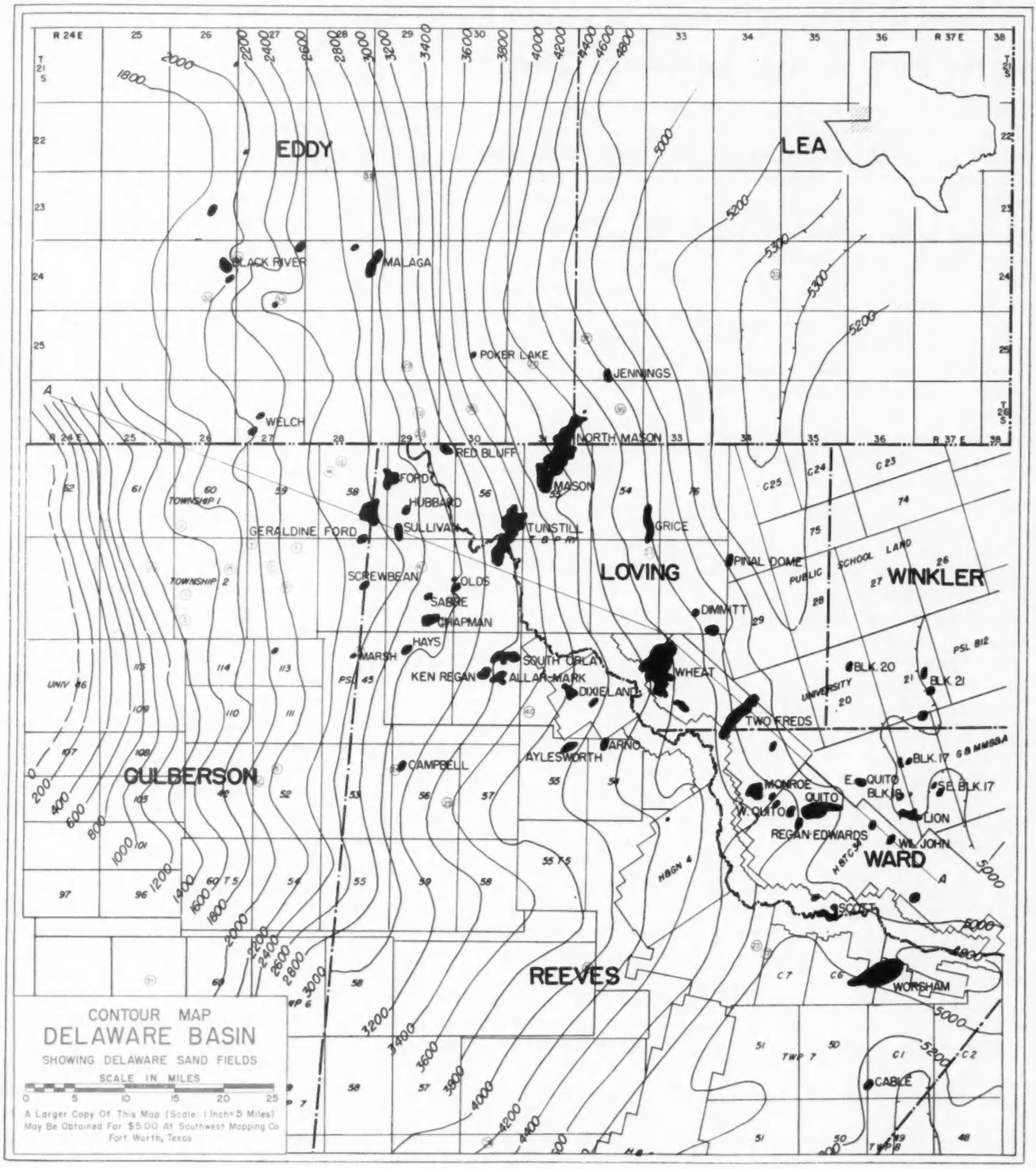
**More farmouts expected.** A large number of Delaware Basin leases will expire within the next three years, further increasing the already heavy farmout activity. Present trends indicate that drilling will be evenly split between large companies and the smaller companies working on farmouts.

More major companies are expected to farm out part of their leased acreage on a checkerboard pattern, offering $1 per foot dry hole contributions to encourage more wildcat drilling.

Although the Delaware Basin is pretty well leased up, there is some

## Five Reasons for the Stepped-Up Activity in Delaware Sands

1. Good production from shallow fields.
2. Farmout activity is increasing, with attractive dry hole contributions.
3. Growing interest in deeper possibilities.
4. Fracturing has greatly improved the output of shallow fields.
5. Relatively few drilling problems.




## Wildcats Drilling in the Delaware Basin as Located on the Above Map, Up to August 15, 1958

1. Sams & Smith Windham-Collier 1
2. T-V Drilling Co. Windham-Collier 1
3. Blue Danube Oil Hollebeke 1-A
4. Blue Danube Oil Pokorny 1
5. Blue Danube Oil Windham 1
6. Bluebonnet Oil Windham-State 1
7. B. J. Brown & Assoc. H. D. Brown 1
8. Burford & Sams Windham-Collier 1
9. Burford & Sams Rupert Cox 1
10. Burford & Sams Rupert Cox 2
11. Chambers and Kennedy Hollebeke 1
12. Continental Oil J. R. Meeker 1
13. Echols Drilling Co. Geo. P. Hill 1
14. Donald M. Oliver Walton Estate 1
15. Schermerhorn Oil Geo. P. Hill 1
16. Ray Smith State 1
17. Geo. C. Koch Smith 1
18. Gulf Oil Todd 1
19. Stephens P. Dillon Gulf Federal 1
20. Gulf Oil Trees 1
21. Hill & Meeker Hal C. Peck 21
22. Geo. C. Koch Patman 1
23. J. R. Meeker Burden 1
24. J. R. Meeker Burden 1-B
25. Jack S. Reaves
26. TXL Oil Reeves-State 1
27. Alamo Corp. Poker Lane Unit 7
28. Gulf Oil Gulf 1
29. J. Glenn Bennett Federal 1-27
30. E. P. Campbell Estill-Federal 1
31. I. W. Lovelady Foster 1
32. Murphy-Dyer Drlg. Co. Marks 1
33. British American Federal 2-D
34. Tenn. Gas State-Kelly 1-B
35. W. J. Weaver State 1
36. Brown & Krug Ben 1
37. The Texas Co. Shaw-Federal 1
38. Geo. H. Williams Federal-Johnson 1
39. Saber Drilling TXL 1-C
40. Bickerstaff & Tibbetts TXL 1
41. Haynes and V.T. Drilling Gulf 1

## "When drilling in Delaware sands, keep the water loss of mud below 15-25cps"

state land still open. However, 1/6 royalty is being asked and the land is being bid in from $20 per acre up, discouraging operators desiring large tracts.

**Air and brine drilling.** Although rotary rigs are by far the most popular, some cable tools rigs are being used in the Basin.

Operators are using both air and water-based fluids. In drilling with air, the time is cut about two-thirds (from 9 days to 3 in shallow areas). However, a long string of surface pipe must be set through the Rustler (twice as much as the length needed for water-based fluids.) and there are still chances of getting sulfur water in stray Castile sections.

The extra cost of brine water is a factor in drilling with brine. However, the mud bill is less than drilling with fresh water. In drilling with brine it is possible to keep a normal in-gage hole—will only be out of gage up to about 9 inches in the entire well. Whereas, with fresh water the salt sections common to the Delaware Basin will wash out up to 36 inches and average hole size well be up to 15.

The average drilling cost in the Basin (Wheat area) is $4 per foot with water-based fluids and $3.25 per foot with air.

In addition to the extra mud costs involved in filling up the washed out salt sections, many of the Delaware sand wells will take up to 4,000 sacks of cement when fresh water is used, compared with 1,000 sacks when drilling with brine if the oil string is cemented to the surface.

Several wells have been very difficult to complete because operators have drilled into the Delaware sands using water only, instead of keeping the water loss of the mud below 15-25 cps.

Time from spud-in to completion: About seven days in shallower areas —14 to 15 days in deeper areas such as the Wheat and Two Freds areas (see map for depths). Average cost from spud-in to completion: $25,000-$30,000 in the shallower areas. Cost in the Wheat field, $50,000-$55,000.

In a typical Delaware drilling program, 8⅝-inch surface pipe is used (200-600 feet) and 5½-4½-inch oil string is set through pay and perforated. Two-inch tubing is used.

**Typical completion program.** Most operators core or drill through pay, running gamma ray-neutron or gamma ray-sonic logs. Four-and-a-half or 5½-inch casing is run and perforated, then completed through tubing although some operators complete through tubing guns with oil in the hole.

Some wells test natural. In most instances the well will have only a slight show of oil and gas. The well is then fractured with 1,000-2,000 gallons of sand frac, 1 pound sand per gallon. Normal injection rate: 5 barrels per minute, after which a good Delaware sand well will backflow the frac load and be ready for potential flow of 100-500 barrels per day on an 8/64 to 16/64-inch choke, with tubing pressures around 500 pounds.

Very few Delaware sand wells are water free, ranging from a trace to 25-30 percent. The crude is 35-40 gravity, sweet, with a paraffin base. In some areas the crude contains salt and a little bit of sulfur.

The most common initial fracturing treatment uses 1,000-2,000 gallons. The rate is usually held down to from 3 to 8 barrels per minute, using the more viscous fluids such as refined oil or jelled lease crudes. This approach usually works fine on the initial treatment.

However, the decline curve of some Delaware sand wells is very rapid. Within 6 to 9 months initial production of 75 barrels per day can be down to 10 barrels per day, making retreatment necessary (with the exception of Geraldine Ford and Two Freds areas). Operators have yet to find a way to get as good a treatment on the second and third tries as on the first. Retreatments large enough to produce results frac into a too high water-oil ratio.

Operators working the basin believe there may be a way to solve the retreatment problem. The possible solution is based on a belief that some parts of the Delaware may be composed of bedding planes. The Delaware sand has very low solubility in acids. However, an operator can put acid in and it will return spent. Thus, the conjecture is that bedding planes are filled with carbonate deposits.

Using this information as the basis, the following theory is offered: In retreatment, use a larger volume of treating fluids (20,000-30,000 gallons of weak—2 to 5 percent—acid solution) and inject 20-25 barrels per minute. This would possibly give fracturing along bedding planes, thus stay out of water.

No one has tried this idea yet. However, there is a possibility that the method would give deeper penetration, slowing the decline in flow rates. It might also help in extending past the previous fracturing pattern.

**General information.** Water availability is good in some areas of the Delaware from shallow water sand and from the Pecos River. Other areas have no water at all—must be trucked in.

The state and country roads are fairly good. Lease roads, of dirt and caliche, are not too good. Kermit, Texas, is the major supply center for the Delaware Basin. —**The End**

**Delaware Sand Completions and Current Drilling Activity in Seven Counties**

| | Wells Completed Jan. 1 to Aug. 1, 1958 | | | | Wildcats Drilling on August 15 |
|---|---|---|---|---|---|
| | Wildcats | | Field Wells | | |
| | Prod. | Dry | Prod. | Dry | |
| **Texas** | | | | | |
| Loving | 0 | 14 | 38 | 2 | 1 |
| Culberson | 2 | 11 | 38 | 1 | 17 |
| Reeves | 2 | 14 | 27 | 1 | 11 |
| Ward | 0 | 1 | 13 | 1 | 0 |
| Winkler | 0 | 1 | 0 | 0 | 0 |
| **New Mexico** | | | | | |
| Eddy | 5 | 1 | 3 | 2 | 9 |
| Lea | 0 | 3 | 0 | 0 | 3 |
| Total | 9 | 45 | 119 | 7 | 41 |

# How predicted and actual performance compared in a West Texas reservoir

## Oil recovery almost exact . . . pressure close . . . GOR approximated

**By E. E. Runyan**
Sohio Petroleum Company, Oklahoma City

A STUDY of the Williams field reservoir, Coleman County, Texas, shows that the predicted performance conforms well with the actual performance of the reservoir. Oil recovery was predicted almost exactly, pressure performance was predicted closely and the gas-oil ratio performance was approximated. Each of the last two factors was thrown in error since wells were shut in as they went to a high gas-oil ratio. This practice had not been allowed for in the original reservoir study but became a necessity when it was found impossible to market the excess produced gas.

Accepted reservoir engineering methods of predicting the behavior of closed reservoirs were applied to the Williams field and the predicted results were compared with those actually obtained under gas injection. It is hoped that this comparison with the original reservoir study based on information available up to the time of initial gas injection, will indicate the accuracy obtainable in predicting the behavior of this type of reservoir.

### DISCOVERY, DEVELOPMENT AND HISTORY

The Williams field was discovered in November, 1943, by Hunter and Hunter Oil Co. of Abilene, Texas, in what is now the Williams Unit 3. The discovery well was completed in the Gray sand for an initial potential of 8 bopd with a GOR of 116,000 cubic feet of gas per barrel. Development proceeded at a moderate rate with 14 wells drilled in 1944 and 13 in 1945. Five wells were dry, and two were completed in a small separate reservoir to the west of the main reservoir. All wells were drilled with rotary tools and spacing followed a nearly regular 40-acre pattern.

Completion practices included setting 100 feet of 10¾ inch surface pipe, drilling to the top of the Gray sand, coring the entire pay interval, logging and setting a 5½-inch production string through the gas cap. All wells are producing from the open hole. No formation treatments were used except in the discovery well, which was shot. Initial potentials ranged from 8 bopd to 900 bopd, and all wells flowed initially.

Production reached a maximum of 22,000 barrels per month in December, 1945, but declined rapidly to 15,000 barrels per month by November, 1946. This rapid decline plus the fact that no gas market was available prompted Sohio Petroleum Co. to investigate the feasibility of re-injecting produced gas back into the gas cap for pressure maintenance. Results of this study were favorable toward gas injection and in December, 1946, the Williams unit was formed with Sohio as operator and gas injection commenced.

The Williams unit comprised 1,440 acres and contained 18 wells, three of which were to be gas injection wells. Three wells at the extreme north end of the field were not included in the unit because operators elected not to participate.

### GEOLOGY AND RESERVOIR CHARACTERISTICS

The producing zone in the Williams field is the Gray sand, a Basal Pennsylvanian sand of the Strawn group, which is usually encountered in this area at approximately 3,750 (—1,750) feet.

The sand in the Williams reservoir lies on the western flank of the Bend Arch and dips to the west at about 100 feet per mile. The average thickness of the sand body is 22 feet ranging from 53 feet in the Williams unit to 8 to 0 feet in the dry holes on the flanks. The reservoir is a stratigraphic trap, and there is no evidence of faulting.

Both the up-dip and down-dip limit of the reservoir are determined by a shaling out of the sand section. No well has produced significant water although two wells have penetrated into apparent water-bearing sand lenses. There is a large gas cap on the up-dip portion of the reservoir with a gas-oil contact at —1,735 feet.

**Summary of core data.** Extensive core data were available on the Williams reservoir since all wells were cored when completed. These cores indicate an average porosity of 14.4 percent and an average permeability of 132 md. based on approximately 275 samples. Since all cores were badly flushed and/or weathered and no capillary pressure test data were available, it was necessary to use

ACKNOWLEDGMENTS

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quantitative electric log interpretation to obtain a connate water saturation. Based on logs from 18 wells, an average of 33 percent connate water was determined.

**Reservoir fluids.** Only one bottom-hole sample analysis was made on the Williams reservoir and, unfortunately, it was not a truly representative sample. It was taken in October, 1945, in what is now the Williams Unit 14. In this sample, the saturation pressure was reported as 1,275 psi. This cannot be correct due to the large primary gas cap. It is obvious that the crude was saturated at the original reservoir pressure of 1,390 psi; therefore, the saturation pressure must be 1,390 psi also. All fluid characteristic curves as taken from the analysis were extrapolated over the necessary pressure range, and calculations were made from these revised curves.

At the initial reservoir pressure of 1,390 psi, the reservoir fluid had a formation volume factor of 1.300, a solution GOR of 600 cubic feet per barrel and a viscosity of 0.47 cp. Bottom-hole temperature was 135° F. at —1,742 feet. The stock tank oil had a gravity of 44.8 degrees at 60° F.

A gas sample was taken from the Williams Unit 3 and analyzed. This sample indicated a gravity of 0.743, a critical temperature of 396° F., and a critical pressure of 665 psia.

**Summary of reservoir and fluid properties.** The following is a tabulated summary of reservoir and fluid properties:

| | |
|---|---|
| Volume of Oil Zone | 8,518 acre-feet |
| Stock Tank Oil initially in place | 564 B/AF |
| Total Stock Tank Oil initially in place | 4,800,000 barrels |
| Volume of Gas Cap | 6,982 acre-feet |
| Gas initially in place in Gas Cap | 469 Mcf/AF |
| Total Gas initially in place in Gas Cap | 3,275 MMcf |
| Solution Gas initially in place | 2,880 MMcf |
| Total Gas initially in place | 6,155 MMcf |
| Porosity | 14.4% |
| Connate Water Saturation | 33% |
| Permeability | 132 md |
| Formation Volume Factor | 1.300 |
| Saturation Pressure | 1,390 psi |
| Original Reservoir Pressure | 1,390 psi |
| Reservoir Pressure at start of Gas Injection | 1,010 psi |
| Original Gas in Solution | 600 cu ft/bbl |
| Gas Gravity | 0.743 |

## RESERVOIR PERFORMANCE PRIOR TO THE START OF GAS INJECTION

To December, 1946, the Williams reservoir was performing as expected. Withdrawal rates had exceeded the expansion of the gas cap, and the bottom-hole pressure was declining rapidly. This was accompanied, of course, by an increase in GOR. Reservoir pressure had declined to 1,010 psi, and GOR's had reached 4,500 cubic feet per barrel in producing only 9.7 percent of the oil in place. Under this type operation, it was estimated that the ultimate recovery from the reservoir would be 22.5 percent of the stock tank oil initially in place or 127 barrels per acre-foot.

A tabulated summary of oil and gas produced from the Williams reservoir to Jan. 1, 1947 is tabulated in Table 1 and is presented graphically in Figure 1.

**TABLE 1—Tabulated Summary of Oil and Gas Produced from Williams Reservoir to Jan. 1, 1947**

| YEAR | Oil Barrels | Cum. Oil Barrels | Gas Mcf | Cum. Gas Mcf |
|---|---|---|---|---|
| 1944..... | 70,808 | 70,808 | 385,510 | 385,510 |
| 1945..... | 218,660 | 289,468 | 539,891 | 925,401 |
| 1946..... | 176,227 | 465,695 | 511,298 | 1,436,699 |

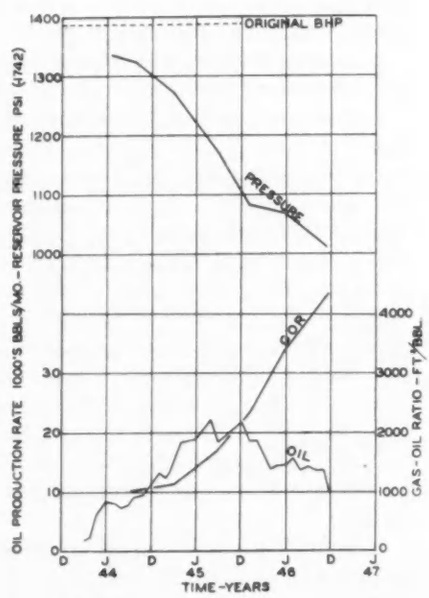


**FIGURE 1—Production history prior to gas injection.**

## FUTURE PERFORMANCE

The future performance of the Williams reservoir was calculated using the Tarner method of material balance. The PVT data used in this calculation came from the previously mentioned reservoir fluid analysis. The relative permeability curve applied was a curve calculated from pool production data and extrapolated into the lower ranges of saturation parallel to published curves for similar reservoirs. The volume of gas to be reinjected into the reservoir was estimated at 80 percent of the produced gas. With these determined, the reservoir performance was calculated in the normal manner. The results of this calculation are shown in Figure 2.

These calculations indicate, assuming a 200 psi abandonment pressure, the reservoir will ultimately recover 1,710,000 barrels of stock tank oil. This is 200 barrels per acre-foot or 35.6 percent of the stock tank oil initially in place. To obtain this oil recovery, it will be necessary to produce about 18,000 MMcf of gas. This entails re-injection of 12,000 MMcf of gas or cycling approximately twice the original gas in place.

## COMPARISON OF PREDICTED VERSUS ACTUAL GAS INJECTION PERFORMANCE

Up to this point, the only information used by the author was field performance to Jan. 1, 1947, or the start of gas injection. With the prediction complete, production records were utilized showing actual field performance up to Jan. 1, 1957. Thus, it is possible to compare the predicted performance with the actual gas injection performance over a 10-year period.

At the outset of the reservoir study,

## *in predicting behavior of this type reservoir*

it was necessary to estimate the ratio of injected to produced gas. This ratio was estimated at 80 percent; that is, 80 percent of all produced gas was to be re-injected into the reservoir for pressure maintenance. This proved to be a valid estimate for the actual injection ratio was approximately 81 percent. It is fortunate that the estimated and the actual re-injected gas volumes were in such good agreement since the predicted performance depends to a large degree on the percentage of gas re-injected.

The comparison of predicted versus actual reservoir performance is based on three factors:

1. Ultimate oil recovery
2. Gas-Oil ratio performance
3. Pressure-production performance

The following is a comparison of these predicted factors to the actual field performance:

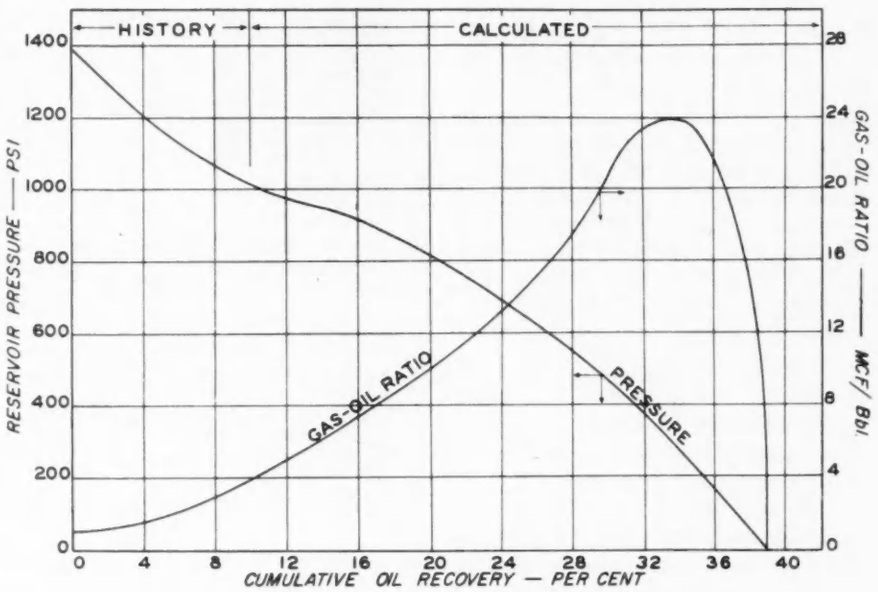


**FIGURE 2—Predicted performance under gas injection.**

**Ultimate oil recovery.** The agreement between the predicted oil recovery and the actual oil recovery is excellent. It is so close, in fact, that it must be considered coincidental to some degree. The predicted oil recovery was 35.6 percent of the initial oil-in-place or approximately 1,710,000 barrels to a depletion pressure of 200 psi. The actual oil production to Jan. 1, 1957 was 1,573,090 barrels or 32.77 percent. Decline curve extrapolation points to 1,750,000 barrels ultimate recovery which is 36.4 percent of the initial oil-in-place. Thus, the agreement between a predicted recovery of 35.6 percent and an apparent actual recovery of 36.4 percent is excellent.

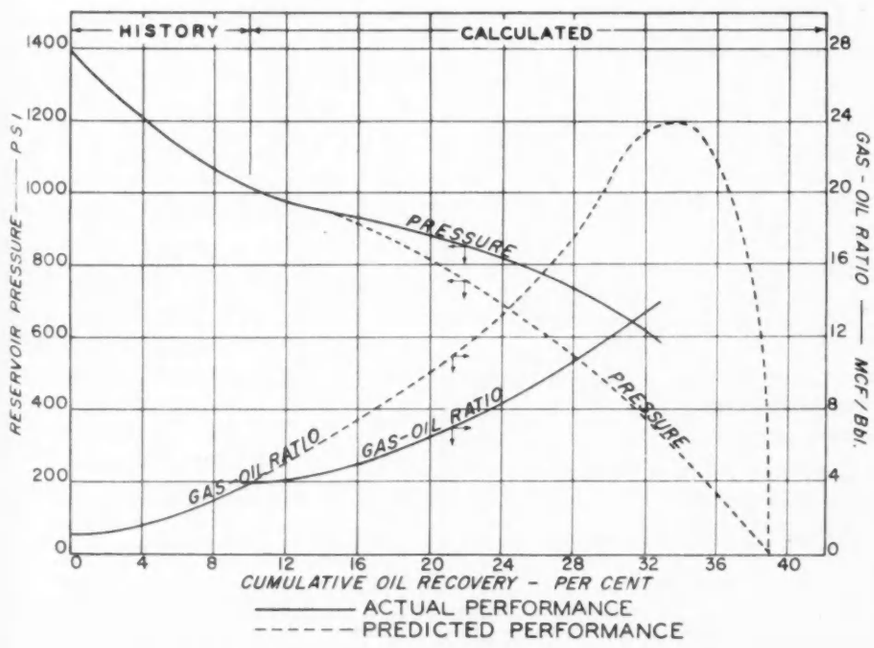


**FIGURE 3—A comparison of actual versus predicted performance.**

**Gas-Oil ratio performance.** The gas-oil ratio in the Williams field has run continuously below the predicted value. For example, at 20 percent recovery the ratio was predicted as 10,000 to 1 while it was actually 6,500 to 1. At 30 percent recovery it was only 12,000 to 1 while it had been predicted at 21,000 to 1. This difference, although large, is very easily explained.

The relative permeability curve used in the study was calculated from production data over the entire field before unitization. Upon unitization, the high gas-oil ratio wells were shut in, thus, in effect, displacing the relative permeability curve to the right. This practice of shutting in high ratio wells was continued until at the present time only four down-dip wells are producing. Since the gas-oil ratio is controlled largely by the $k_{rg}$ curve and the $k_{ro}$ curve is dependent on the reservoir saturation, the actual gas-oil ratio is a reflection of the reservoir saturation around only the four

down-dip producing wells rather than the whole reservoir.

**Pressure-production performance.** The reservoir pressure performance prediction is in fairly good agreement with the actual performance, the actual being slightly higher than predicted. The practice of shutting in high ratio wells contributed to this since even though 80 percent of the produced gas was returned to the reservoir the remaining 20 percent was lost. Therefore, by producing a smaller amount of gas the total volume was reduced, thus tending to sustain the reservoir pressure.

Probably the dominant factor in the higher actual reservoir pressure is the presence of a tight "feather-edge" gas zone of the undetermined volume around the up-dip section of the gas cap. This zone is the area in which the sand lense grades back into the shale and, consequently, is very tight. Due to its low permeability, it does not show up during short time intervals such as pressure surveys; however, over the life of the field it does bleed a sizable quantity of gas into the gas cap thus sustaining the pressure.

The actual results of the Williams field gas injection project are shown in Table 2 and the predicted and actual results are shown graphically in Figure 3.

**About the Author**

**E. E. Runyan,** Sohio Petroleum Co., Oklahoma City, was graduated from the University of Tulsa with B.S. and M.S. degrees in petroleum engineering. He joined Sohio in 1955 as a junior engineer in Baton Rouge, La., and shortly afterwards was transferred to the Oklahoma City office where he is staff petroleum engineer for the company's Mid-Continent division.

**TABLE 2—Actual Reservoir Performance Under Gas Injection**

| DATE | Cum. Oil | % Oil | Gross Cum. Gas | GOR | BHP |
|---|---|---|---|---|---|
| April 1947 | 524,213 | 10.92 | 1,676,783 | 3,952 | 959 |
| June 1947 | 554,220 | 11.55 | 1,788,049 | 3,850 | 973 |
| Nov. 1947 | 636,025 | 13.25 | 2,090,190 | 3,800 | 968 |
| March 1948 | 703,660 | 14.66 | 2,331,761 | 3,800 | 951 |
| Nov. 1948 | 828,549 | 17.26 | 2,934,768 | 5,127 | 903 |
| Oct. 1949 | 960,838 | 20.02 | 3,753,791 | 6,684 | 856 |
| Nov. 1950 | 1,095,592 | 22.82 | 4,722,212 | 7,680 | 848 |
| Jan. 1952 | 1,235,569 | 25.74 | 5,915,795 | 8,290 | 795 |
| August, 1952 | 1,294,396 | 26.97 | 6,461,102 | 10,040 | 758 |
| Sept. 1953 | 1,384,189 | 28.84 | 7,345,152 | ..... | 740 |
| Oct. 1954 | 1,446,859 | 30.14 | 8,189,480 | ..... | 689 |
| April 1955 | 1,481,954 | 30.88 | 8,601,183 | 12,229 | 647 |
| Oct. 1955 | 1,510,694 | 31.47 | 8,926,228 | 12,852 | 659 |
| Jan. 1, 1956 | 1,516,719 | 31.60 | 9,030,886 | ..... | ... |
| Jan. 1, 1957 | 1,573,090 | 32.77 | ..... | ..... | ... |

## CONCLUSIONS

The Tarner method of predicting the future performance of petroleum reservoirs has been applied to a specific gas injection project which now is in the latter state of depletion. The method was first applied using information available up to the time of initial gas injection. The results of this application were then compared to the actual results obtained after 10 years of gas injection.

From this comparison, it has been shown that:

- The predicted ultimate oil recovery is in very good agreement with actual ultimate oil recovery.
- The actual gas-oil ratio is lower than predicted.
- The actual reservoir pressure is slightly higher than predicted.

It it is permissible to go from the specific to the general based on only one case, it may also be said that the Tarner method of predicting the future behavior of petroleum reservoirs is an acceptable tool for reservoirs of the Williams field type. However, the accuracy obtained here is coincidental to some degree and should not be expected in the majority of cases.

## How good a driller are you?

A quiz for oil field folks. Score as follows: 0-4 (Weevil); 4-8 (Mud Doctor); 8-10 (Expert). One point for each correct answer.

1. **Which of the following ions are difficult to treat out of sea water:**
   **(a) calcium (b) magnesium (c) chloride.**
2. **Most mud pump horsepower is expended by pumping the drilling mud**
   **(a) down the drill pipe (b) through the bit (c) up the annulus.**
3. **A lime base mud derives its name from the fact that it contains:**
   **(a) $Ca(OH)_2$ (b) $CaCO_3$ (c) $CaSO_4$**
4. **Which of the following is not a calcium base mud:**
   **(a) Gyp mud (b) lime mud (c) phosphate mud.**
5. **Match the following oil field term with its use or meaning:**

| | | |
|---|---|---|
| (a) rat-hole | 1. | Where joint of pipe is placed before adding to dull string |
| (b) mouse-hole | 2. | clothes washer |
| (c) blow barrel | 3. | mud does not return to surface |
| (d) spudding-in | 4. | start drilling a well |
| (e) lost circulation | 5. | where kelly is racked when making a trip |

**ANSWERS**

1. c; 2. a; 3. a; 4. c; 5. 1-b; 2-c; 3-e; 4-d; 5-a.

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[3] Pirson, S. J.: *Elements of Oil Reservoir Engineering*, McGraw-Hill Book Co., Inc., New York, (1950).

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## Proved Recoverable Reserves of Crude Oil

(thousands of barrels)

| | January, 1941 | January, 1957 | Change % |
|---|---|---|---|
| Texas Panhandle | 697,512 | 430 | - 38 |
| Kansas | 692,088 | 998,000 | + 44 |
| Oklahoma | 1,000,909 | 2,053,000 | +100 |

## Production, Annual

(thousands of barrels)

| | 1940 | 1956 (prorated) | Change % |
|---|---|---|---|
| Texas Panhandle | 27,757 | 35,857 | + 30 |
| Kansas | 66,270 | 121,643 | + 83 |
| Oklahoma | 155,592 | 277,775 | + 80 |

**FIGURE 1—Production changes in the northern Mid-Continent region during the last 15 years—from 1941 to 1957. For example, when reserves of Oklahoma in 1941 were approximately 1 billion barrels, many maintained that discoveries were beginning to end. However, another billion barrels of recoverable reserves have been added in addition to the 3 billion barrels produced during this period.**

# The Mid-Continent—a land of geological opportunity

**This oil and gas region is one of the best places in the world to learn the petroleum industry and to practice petroleum geology.**

**By Dr. A. I. Levorsen**
Consulting Geologist, Tulsa

THE MID-CONTINENT is one of the best places to learn the petroleum industry and to practice the geology of petroleum because:

- The Mid-Continent is a land of oil and gas.
- It is a land of great geological diversity.
- Many oil men are concentrated in this region.
- This area is an example of what might be termed the "American System" of finding oil.

**Land of oil and gas.** Hundreds of oil and gas pools—large and small, shallow and deep—have been found in the Mid-Continent. In fact, this area has one of the greatest concentrations of oil and gas pools in the world. And the northern Mid-Continent region is still going strong after over 50 years of exploration.

Where can one find an area as big as the Northern Mid-Continent with as many measured geologic columns with which to work?

One might wonder, after seeing maps and charts such as these, how much longer this upward rate of oil and gas discovery can continue? During the past 40 years in the Mid-Continent region, there has been concern that the end of discovery was in sight—or if not in sight, at least soon would be. And yet there have always been new areas of promise, and discoveries have continued both with and without the benefit of geological advice.

Despite all that has been learned of the geological conditions in the Mid-Continent and where its oil and gas pools are located, there still are large areas of promise that as yet have not been found to be very productive.

These are called "Not Yet" areas, and some of them are shown on Figure 4. They include:

- The northern buried Nemaha Mountain range of Kansas and Nebraska
- The Forest City Basin of Northeastern Kansas and Northern Missouri
- The Salina Basin of Northern Kansas, extending into Nebraska
- The northern extension of the Sierra Grande uplift of Eastern Colorado and Western Kansas
- The central, deep part of the Anadarko Basin of Western Oklahoma
- The Boston Mountain region of Northwestern Arkansas
- The Ouachita Mountain region of Oklahoma.

There appears to be little difference in the outlook now than 10, 20 or 30 years ago. Many pools have been discovered, and by that amount the ultimate is decreased; new data added from discovery gives promise of at least as much, if not more, oil yet to come. Discovery and outlook, in other words, keep in balance.

There still are as many good prospects as ever on the drawing boards of the geologists working in the Mid-Continent. And some are as big as any that have been seen in the past. Given the incentive, some of these will turn into oil and gas pools. From those that fail, other prospects will develop. The end is not yet in sight.

**Geological diversity.** The geology of the Mid-Continent region is essentially Paleozoic geology. Except for a few small pools in Cretaceous rocks in Southern Oklahoma and some pre-Cambrian production in Kansas, all oil and gas production is from Paleozoic rocks. Every system of the

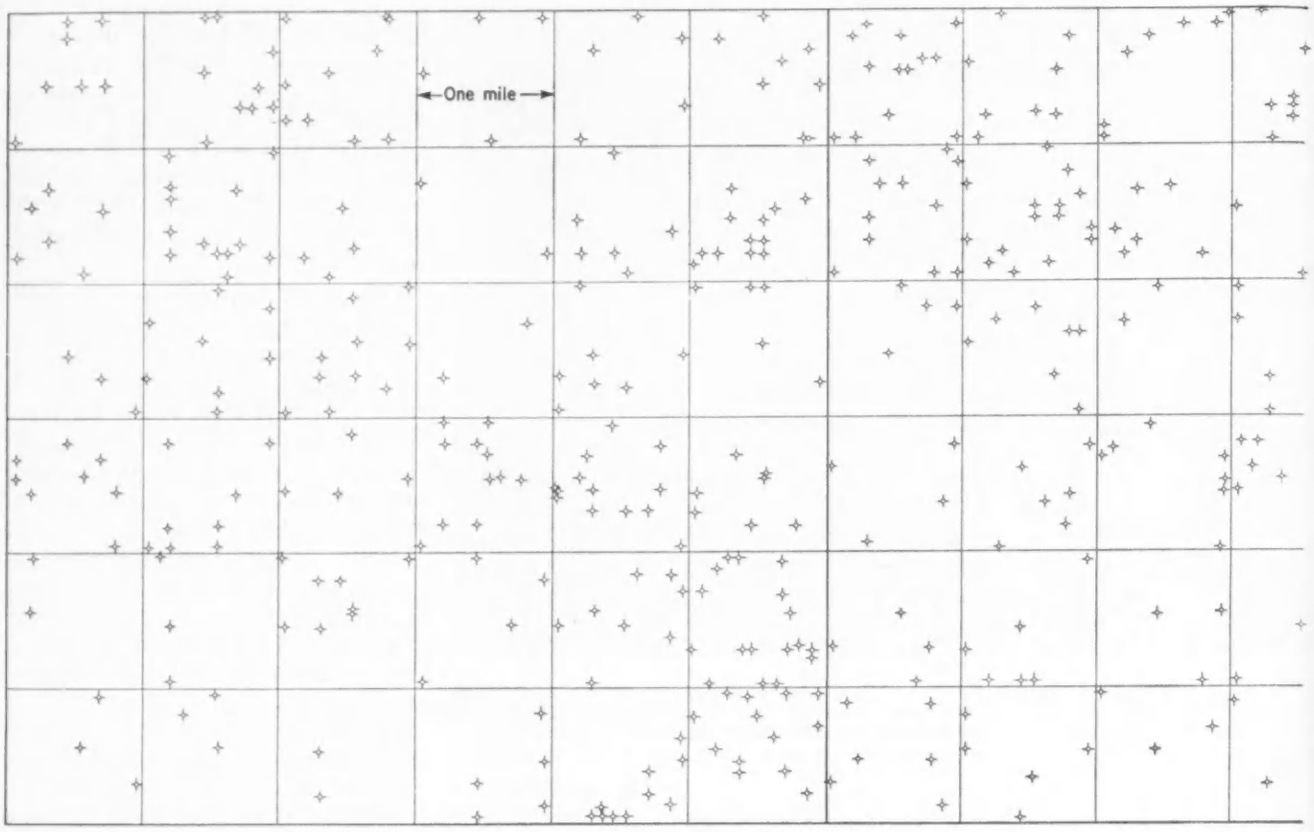



**FIGURE 2—Many dry holes must be drilled in the never-ending search for new pools. This portion of eastern Oklahoma shows a typical active area.**

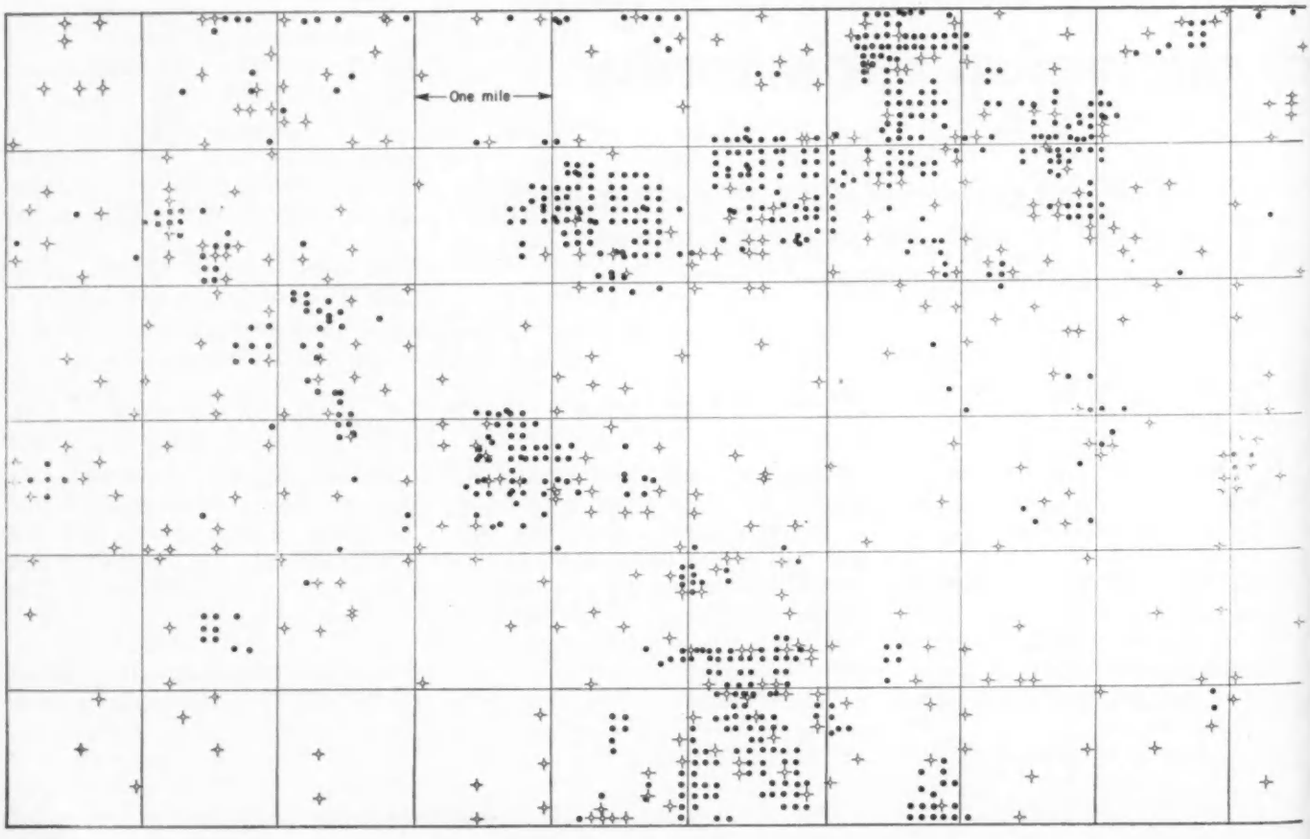



**FIGURE 3—The same area of Figure 2 is shown with the oil pools added. A count of the holes in this area, 57 square miles, shows that there are 388 dry holes and 669 oil wells. This is an average density of 7 dry holes per square mile.**

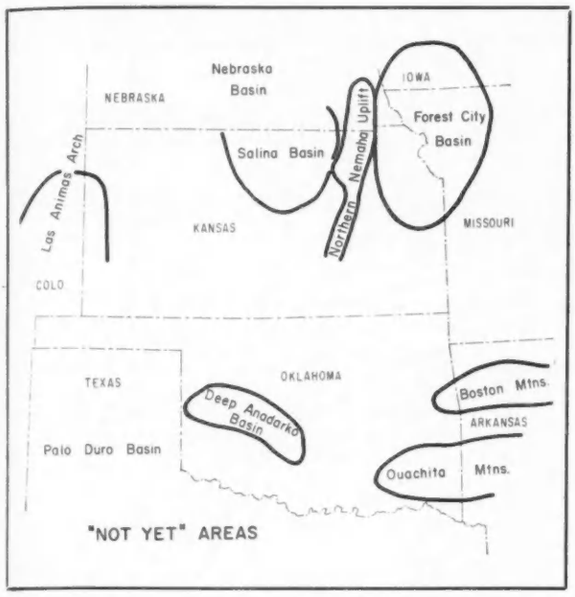



**FIGURE 4—There are many large "not yet" areas of the Mid-Continent that show promise but that have not as yet been found productive.**

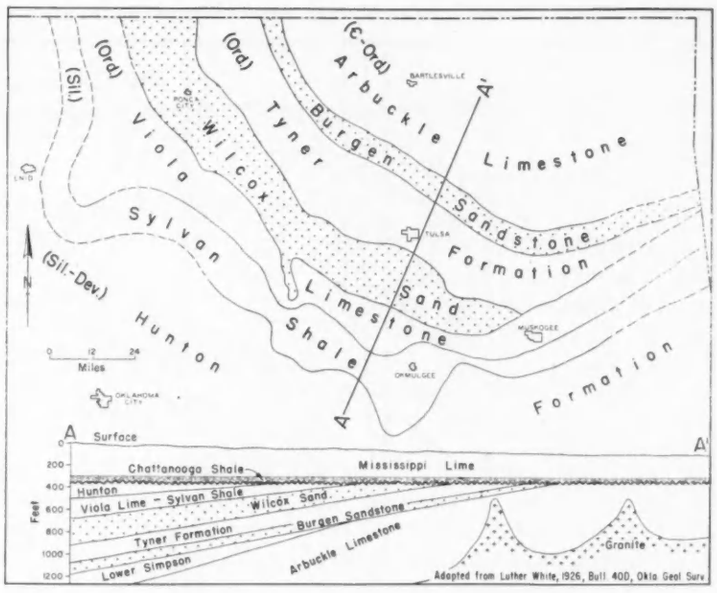



**FIGURE 5—The pre-Mississippian of northeast Oklahoma. This is but a "hand specimen" of a condition that extends over the entire U. S.**

Paleozoic is productive at some place or other. In some localities, several systems, one above the other, are productive. It is by far the best place in the world to study Paleozoic geology, for here the entire Paleozoic era is laid out and detailed in four dimensions—length, breadth, depth and time.

Experience, likewise, can be gained in working with many different kinds of rocks. Shales, limestones, dolomites, sandstones, arkoses, evaporites, and all combinations of these give abundant opportunity to learn the way each kind of rock reacts to folding, to the various logging devices, to geophysical measurements, and to petroleum production.

Many have thought of much of the Mid-Continent as a 10-foot contour region—structure, isopach and reservoir—characterized by simple, low folds on a rather uniform westerly regional dip of 40-60 feet per mile. This leads to careful, precise technology and thinking.

It has been found, however, that below this seeming uniformity there exists an almost unbelievable and unpredictable complexity of structure and stratigraphy. About the only type of structure that is not found is the salt plug—diapir, such as are common in the Gulf Coast and in many places in France and North Africa. Many great mountain ranges with tens of thousands of feet of sediments involved are found at many places below the surface. (See Figure 7.)

Unconformities, which might be likened to the chapter headings in the geological history book of the rocks, abound in the Mid-Continent. Seldom is there an oil or gas pool over 50 feet vertically from some kind of an unconformity.

The importance of unconformities in exploration philosophy is nowhere brought out more effectively than here. As each of the major unconformity surfaces was penetrated, it opened up new layers of rocks to explore. In fact, four landmarks in the exploration of the Mid-Continent were marked by discoveries of new geological conditions—and new oil and gas accumulations below unconformity surfaces. Illustrated in Figures 5 through 8, they are:

1. The pre-Mississippian of Northeast Oklahoma.
2. Pre-Pennsylvanian of the Oklahoma City field.
3. Pre-Pontotoc (Pre-Permian) of Southern Oklahoma (Milroy field).
4. The pre-Cretaceous of North Texas (Handy field) and Southern Oklahoma.

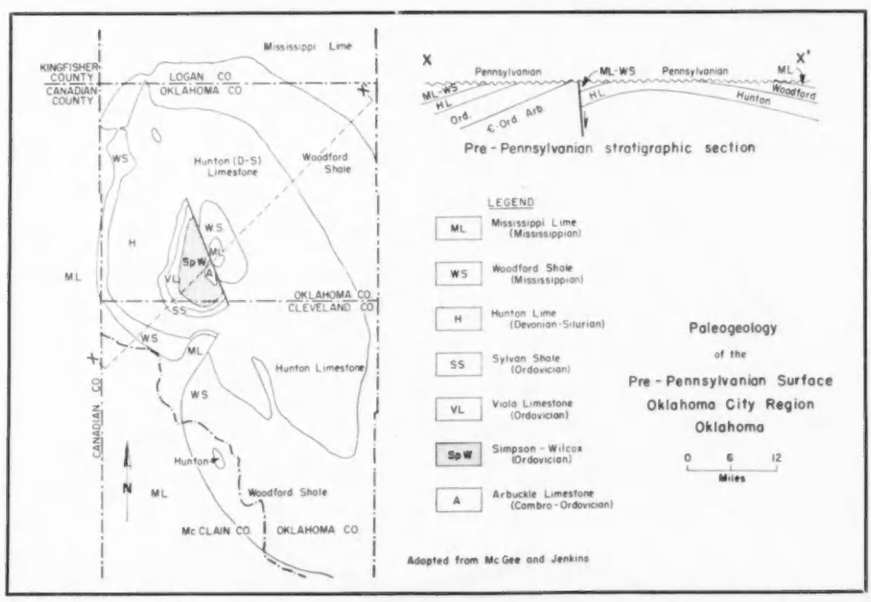



**FIGURE 6—Pre-Pennsylvanian of the Oklahoma City field opened up the importance of this surface of unconformity. This marks the beginning of the active search for "baldheaded" traps, although some had been discovered before this. This unconformity, too, extends through a large area in the U. S.**

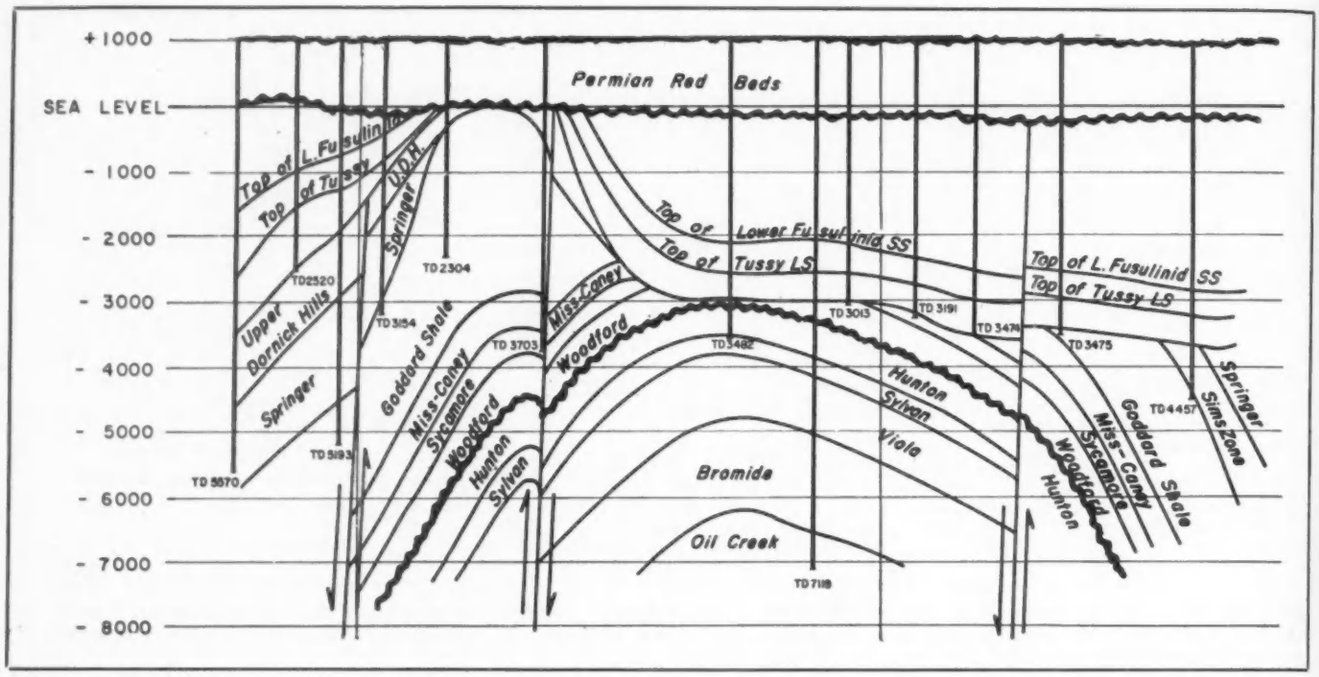



**FIGURE 7—The pre-Pontotoc (pre-Permian) of southern Oklahoma's Milroy field. This period marks the end of a period of mountain building and violent uplift, faulting, folding and truncation, all of which contain oil and gas pools. The time required for exploration will be long because of the complex geology.**

Another great opportunity in the Mid-Continent lies in the vast amount of information available for study. Logs of all kinds, production records, drill stem test records, scout reports, acidization records and core analyses are available in great quantities, nearly all free or nominal in cost.

In addition to well records and production data, many technical societies, companies and agencies hold innumerable technical meetings or give instruction in interpretation of data.

**Concentration of oil interests.** Some oil men operate as individuals; most, however, are in some sort of an organization. These organizations are large and small, vertical and horizontal in scope, and operate in all phases of the petroleum industry. Considerable time and effort are spent in the Mid-Continent improving the ways in which organizations function, how to get the most for the least, how to deal with each other and how to handle the chains of command within the organization. The opportunities for learning about organization, teamwork and management are unsurpassed.

The U. S. oil industry has been free to develop in the way best suited for its growth, in what may be called a "free system" in which ability—and not school, caste, or politics—is the dominant guide.

Many specialists are found in the geological group. Some are like the paleontologist. He is a biologist when he works with the taxonomy of the fossils, but he becomes a geologist when he interprets the fossils into geological concepts.

The same is true of the geophysicist. As a physicist, he measures and records the properties of rocks, but as a geologist, he interprets these measurements into the structure, facies and history of the rocks and predicts where

*(Continued on Page 115)*

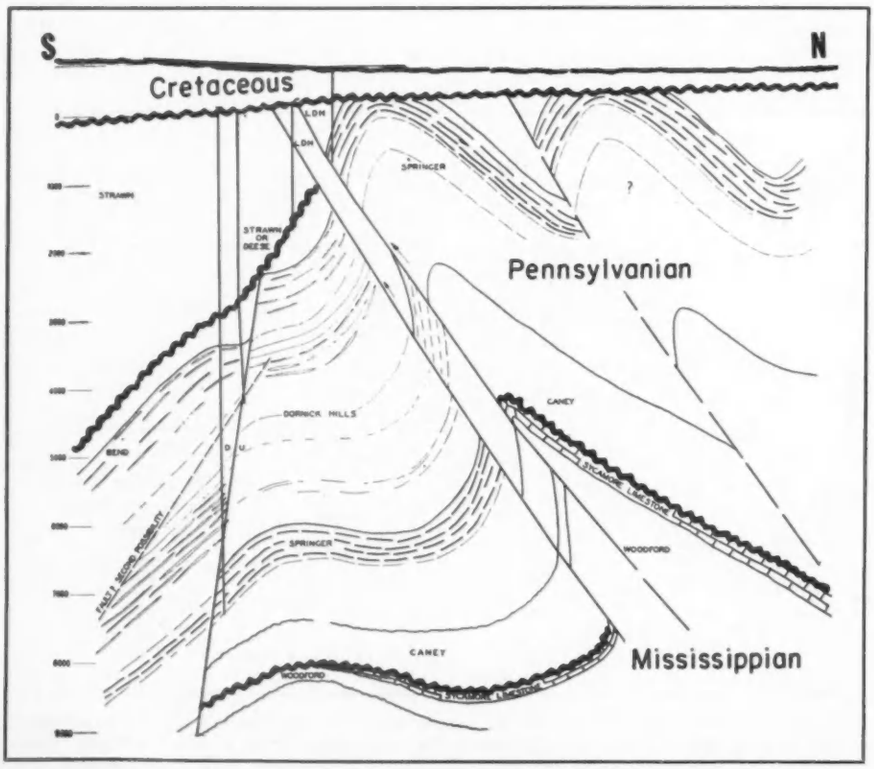



**FIGURE 8—The pre-Cretaceous of North Texas (Handy field) and southern Oklahoma.**

*On offshore rigs . . .*

# Cantilever drilling barge has diesel-mechanical power

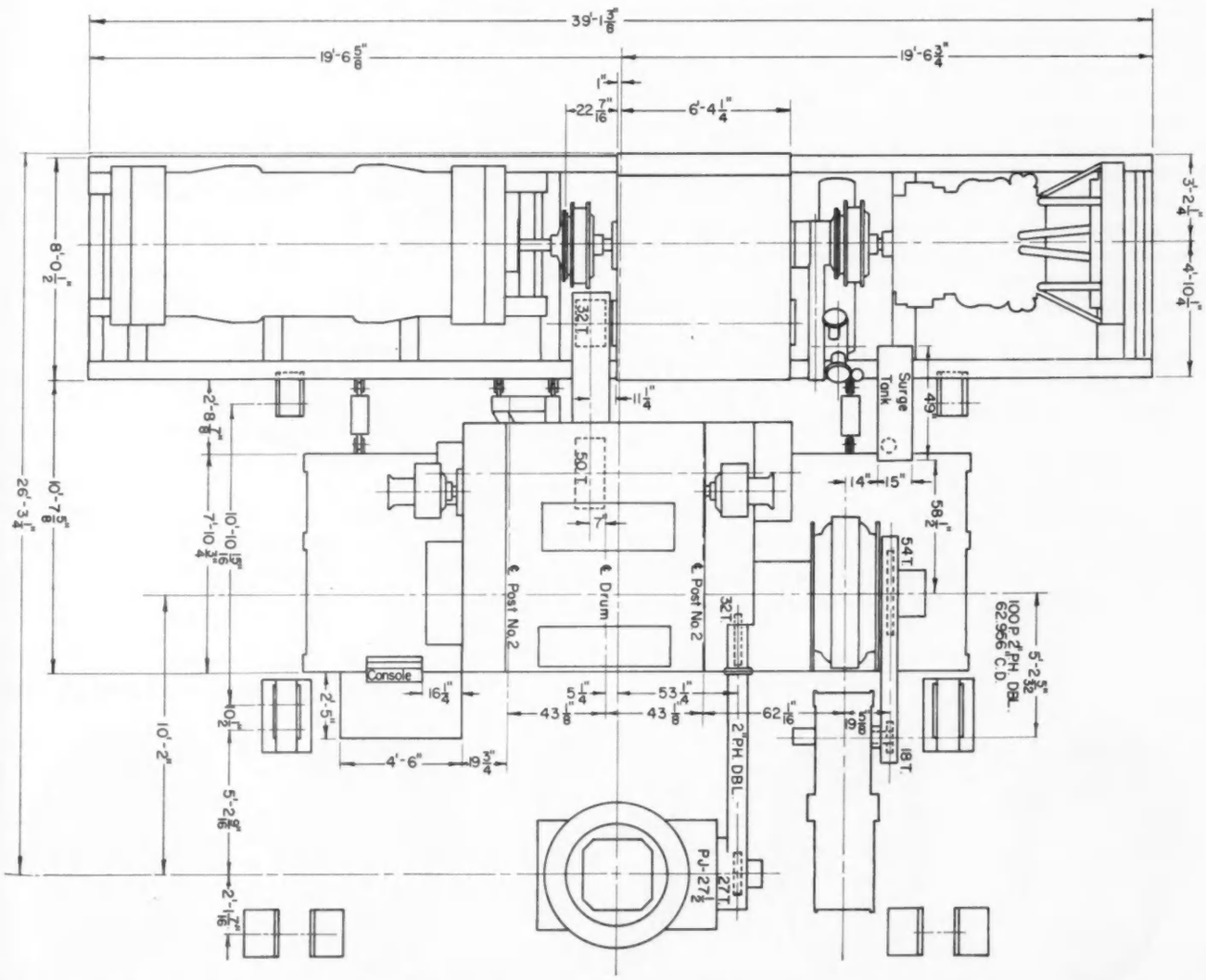
**Only diesel-electric has been used in this application in the past due to space limitations.**

THE FIRST cantilever type drilling barge to use a diesel-mechanical power drive is now operating in the Gulf of Mexico. Rimrock Tidelands' *Rimtide* is drilling for Gulf Oil Corporation in Block 49, Main Pass.

Movability of cantilever barges has made them preferable to those with "key way slots." But lack of space has dictated the use of diesel-electric power source. Preferences for the mechanical type of power brought about the new design used on the *Rimtide*. The diesel-mechanical power pack consisting of a 1,000-hp quad engine and a 500-hp twin engine is used.

The drawing shows the layout and dimensions necessary to incorporate a mechanical power drive. Over-all distance from the center of the rotary table to the back of the engine skid is 26 feet, 3¼ inches. Distance from the front of the drawworks is 18 feet, 8⅝ inches. Room between the engine and the wall is confining, but passable.

Engines are separately clutched into a selective gear box. Only the twin engine will be operating when rotating. For hoisting, the quad will then be used, giving an available hoisting capacity of 600,000 pounds of pull with a 12-line stringup. With the engine flexibility, as many as two of the six engines making up the power package can be removed for emergency repairs without interrupting operations.




**Space was of the greatest concern in designing a cantilever type barge using diesel-mechanical power. The above figure is a dimensional layout showing the drawworks, the selector gear box, and the diesel-mechanical power pack. —The End**

## Mid-Continent problems aired

# Experts answer questions on

WATER-FLOOD OPERATORS from Oklahoma and Kansas posed questions and received answers on a variety of water-flood problems at a "Quiz Program" held in Independence, Kan. The program was sponsored by the U. S. Bureau of Mines, Bartlesville, Okla.

Program chairman was J. P. Powell, engineer with the Bureau of Mines. Don Hockaday, Kewanee Oil Company, Tulsa, acted as moderator. Members of the panel included R. O. Perry and Don Holbert, Sinclair Research Laboratories, Tulsa; Dick Waters, Sunray-Mid-Continent Oil Corporation, Tulsa; Jesse Wyrick, The Pure Oil Company, and Joe Vaughn, American Climax Petroleum Corporation, both of Nowata, Okla.

Following are the questions and answers:

**Q.** *What is the basis for determining proper injection rates at the start of the flood and later when the flood has become stabilized?*

**A.** Most companies use about 1 or 1½ barrels per day per acre foot as an initial injection rate to obtain fill-up. About 1 barrel per day per acre foot is used for the remainder of the flood's life. Actually, the basis for determining injection rates would be how soon an operator wants to recover the oil. Engineering calculations show that it would take one barrel per day per foot of sand to reach an eight-year flood life. There are numerous floods in which injection rates are lower because of wellhead pressure limitations. In these instances, the average injection rate over the life of the flood may be as low as ¼ to ½ barrel per day per acre foot of sand.

**Q.** *What is the latest method for plugging channels (fractures) between wells?*

**A.** One company has been experimenting with polymerizable plastics as a plugging agent. The plastics are placed in the well in a liquid phase and are held in place until they polymerize into either a solid or a stiff liquid gel.

**Q.** *What is the value of cement-lined pipe when a water-flood is abandoned?*

**A.** Any recoverable pipe cement lined at the start of the flood would have the same amount of salvage value if it was not pitted from external corrosion. As long as the couplings were in good repair it should have considerable value when the flood is abandoned.

**Q.** *Is areal sweep efficiency of a pilot water-flood a factor to be considered in the evaluation of the pilot flood or in the planning of a field-wide flood?*

**A.** If the areal sweep efficiency was zero, an operator would not be concerned with the evaluation of the pilot or the water-flood. The 70 percent figure given by Muskat in his original theoretical and laboratory work is used in most evaluations. There has been work published using immiscible fluids that indicate the eventual sweep efficiency might be better. The question is, how much longer would it take to increase it to 80 or 90 or possibly 99 percent?

One company tried to determine the sweep efficiency by drilling wells in an old area that had been water-flooded. It was assumed that there was banked oil trapped in the reservoir. No oil was found. It can be assumed that the efficiency may be greater, certainly more than the 70 percent normal areal sweep for a five-spot pattern.

**Q.** *If it is desired to mix fresh water at the rate of 1,600 barrels per day containing 1.9 parts per million oxygen with 400 barrels per day of brine containing hydrogen sulfide of an unknown concentration, what treatment will be necessary?*

**A.** Any time fresh water with dissolved oxygen is mixed with water containing hydrogen sulfide, free sulfur and iron sulfide will be precipitated. One of the best treatments (one that has been tried in the Nowata area with Arbuckle water) is to pass the brine through air or flue

**Here are the men who made this**

Don Hockaday

Jesse Wyrick

R. O. Perry

Don R. Holbert

Joe Vaughn

# water-flooding

gas to remove all the hydrogen sulfide. Decent injection water will be obtained if this is done in conjunction with a regular open treatment system. Arbuckle water is very hard to handle due to its corrosive nature.

**Q.** *How much hydrogen sulfide can be tolerated in an injection water?*

**A.** This question has been asked many times by operators who have only Arbuckle water for injection. Originally, it was throught that a safe upper limit of hydrogen sulfide concentration was about 20 parts per million. There is a system in Texas using brine with 500 parts per million hydrogen sulfide. It was not known how long the equipment would last. It was the general opinion that the upper limit is about 50 parts per million. Several systems within that range are not having too much trouble.

**Q.** *Is permeability stratification usually an important factor in oil-recovery efficiency from the average sandstone type reservoir?*

**A.** The consensus among the panelists was that permeability stratification is an important factor in the oil-recovery efficiency from such a reservoir.

**Q.** *What is the effect of fracturing on over-all recovery from water-floods?*

**A.** One panelist cited the results of two frac jobs recently performed in northeast Oklahoma. One well was initially shot with two quarts of liquid nitroglycerin per foot of sand. The permeability of the sand averaged 20 millidarcys. The well was fractured with 3,000 gallons of oil and 6,000 pounds of sand. Presently, it is producing 19 barrels of oil and 150 barrels of water per day. Another well, in a flood that had passed fill-up, was fractured. Production from this well has not stabilized. It now is flowing 40 barrels of oil daily. In all, more than 50 wells were fractured in this area and plans are underway to fracture several more.

## report possible

J. P. Powell

Dick Waters

Another panelist reported that his company had not fractured many producing wells. The company fractured one well on a 2½-acre spaced flood. Prior to fracturing, the well was flowing 170 barrels of water and 8 to 10 barrels of oil per day. After fracturing, the well flowed 340 barrels of water and 25 barrels of oil daily. When the well was put on the pump, production increased to 36 barrels of oil and 500 barrels of water per day.

**Q.** *Discuss the salvage value and cost of salvaging a typical 500- to 800-foot well in a water-flood in the Kansas-Oklahoma area. Consider both producing and injection wells.*

**A.** One panelist reported that his company was in the process of evaluating the salvage of wells in that depth interval. From available data, this operator would be glad to give the wells away if the recipient would assume the responsibility of plugging them.

**Q.** *Is catalyzed sodium sulfite being used for the removal of dissolved oxygen?*

**A.** It has been tried, but not too successfully. Sodium sulfite tends to form a solid coating on the pipe when used in brines.

**Q.** *Is it necessary to use large volumes of plugging material for effective selective plugging? Will short penetration of plugging materials from the well bore be effective?*

**A.** One panelist reported his company was successful with small quantities (50 to 100 gallons) of polymerizable plugging material. The company prefers to confine selective plugging to cases where channeling is known to exist.

In cases where tracer tests are available or water from an injection well appears in four or five nearby producing wells, channelling definitely exists and must be corrected if oil is going to be produced from the flood. In these cases, successful plugging has been obtained with small quantities of selectively placed plugging material.

**Q.** *What have been the results obtained from selective plugging?*

**A.** One panelist reported that selective plugging has been successful. In this case it was difficult to pinpoint results since the flood was only recently completed. It was found that after selective plugging the tracer (that previously appeared in surrounding wells in four or five days) did not appear after 30 days of testing.

**Q.** *Is rapid or slow injection better with respect to economics or ultimate recovery?*

**A.** It was the opinion of one of the panelists that both rapid and slow rates of injection had their place in water-flooding. It was his opinion that it was better to recover the oil as soon as possible because of the high initial investment incurred in the development of a water-flood.

Rapid injection possibly will not result in the greatest ultimate recovery, but about 80 percent of the development costs are fixed charges that should be paid off as quickly as possible.

Slow injection would increase the life of the flood. If the flood life is extended over too long a period (8 to 10 years) however, much equipment will require replace-

ment. This will considerably increase operational expenses and reduce the margin of profit.

**Q.** *Some operators install 4-inch pipe in injection wells. What has been the panel's experience in reconditioning wells completed with 4-inch pipe?*

**A.** One panelist reported that his company was successfully using 4-inch injection strings in some areas. In the Nowata area, injection wells are completed with either 1½- or 2-inch cement-lined pipe set with a rag packer and cemented. Remedial work consists of running a macaroni string inside the tubing and washing or acidizing the well to restore its original injectivity.

**Q.** *What are some of the advantages and disadvantages of locating water meters at central locations as compared to meters at each well?*

**A.** Central meter installations can be economically advantageous on certain floods. The use of central metering headers depends upon well spacing, size of flood and surface contours of the field. One advantage of centrally located meters is that less time is required to read and adjust injection rates.

**Q.** *Is it always necessary to plug off bottom water? What is the best method?*

**A.** The necessity of shutting off bottom water depends upon the type of well under consideration. In the Delaware-Childers field, one company finds it necessary to shut off bottom water because of a natural bottom water drive. Wells usually are completed above the water sand. When wells are accidentally drilled too deep, bottom water is plugged off with cement.

**Q.** *Have any panel members had experience in fracturing input wells to increase receptivity?*

**A.** Yes. Water input wells will usually accept more water after fracturing.

**Q.** *Has the use of closed water-treating systems been satisfatcory?*

**A.** In most cases, use of closed water-treating systems has been satisfactory. Hydrogen sulfide content should be kept at a low value when using these systems.

**Q.** *An operator wishes to fracture three separate zones of different permeability in the same 20-foot sand section in a producing well. Is such a procedure feasible?*

**A.** It was the opinion of one panelist that it was not practical to selectively fracture in a 20-foot sand section with three sets of perforations. Usual practice is to have approximately 12 feet of blank pipe between perforations. The panelist cited a case where his company tried to selectively fracture a well using moth balls. Tracers run after the frac job indicated fracturing in three or four sections of a 50-foot sand block.

**Q.** *What is the effect of altering the flow pattern so that the flow direction is at right angles?*

**A.** In one field in Pennsylvania, an operator grouped a number of properties and abandoned all water-input wells. Every other oil well was converted to an input well. This changed well spacing from about one well to 2½ acres to 1 well to 5 or 7 acres. Additional oil was recovered but it is not known whether the operation was economically successful.

It was the opinion of one panelist that very little additional oil is recovered by cross flooding or infill drilling midway between injection wells. However, in the North Burbank field, Oklahoma, an operator converted several input wells to producers and recovered commercial quantities of oil for some time. These wells had been on injection for four or five years and probably had accepted 700,000 to 800,000 barrels of water.

**Q.** *Is a pilot flood operation representative of a full field project?*

**A.** It was the general opinion of the panel that a pilot operation can not be ratioed to a given flood from an economic standpoint. The oil recovery gained in the pilot operation is not indicative of the recovery from a full scale flood. A pilot flood is considered by some operators as a preliminary operation to determine if the property is floodable and as a means of determining the cost of developing the entire property.

**Q.** *What factors should be considered in determining the optimum charge to be used in fracturing producing wells?*

**A.** One panelist reported that his company had found no direct relationship between the size of the job and the results obtained. By trial and error, the company had settled on using 3,000 gallons of oil to 6,000 pounds of sand for 25 feet of sand section.

**Q.** *Is a peripheral flood a better type mechanism than a pattern flood?*

**A.** Assuming that sufficient water can be introduced into the formation, the panel was prone to favor a peripheral flood.

**Q.** *Which is better, perforating or an open hole completion?*

**A.** One panelist reported his company had tried both completion methods and found that both had their place in water-flood development. The company sets 4½-inch pipe in injection wells. If pipe is set on top of the sand and trouble is encountered at the bottom of the hole (such as channeling), the only remedial work that can be done is to plug back with cement and hope the job is successful. If pipe was set through the sand and perforated in an undesirable section these perforations could be squeezed off and the water confined to the pay zone.

**Q.** *How soon after discovery is it feasible to apply water injection in a solution drive reservoir?*

**A.** One panelist suggested that 24 hours would not be too soon. Some advantages of early water-flooding are:

- It is apparent that the formation volume factor of an area is going to affect the amount of reservoir oil that can be swept. Some advantage is obtained in commencing early water injection in that more reservoir space is swept.
- The initial investment usually is low. In Osage County, Oklahoma, water injection was started on a property when saturation pressure dropped from 1,050 psi to 900 psi. The saturation pressure was built immediately to the original 1,050 psi and has been held at that pressure. Approximately 100 percent of the estimated primary production has been recovered and the project is still flowing. In Texas, where proration is in effect, there is no advantage to early flooding. —**The End**

# Deep gas play active in Pennsylvania, W. Virginia

**Modern drilling and producing methods, good gas price structure stimulate long-dormant structural trend. Rotary rigs take over as air and gas drilling solve hard rock drilling problems**

MODERN AIR and gas drilling methods have essentially overcome the extreme hard-rock problems in western Pennsylvania and northeastern West Virginia, largely replacing cable tools to effect rapid development of a lucrative structural trend spanning more than 200 miles. Though the big surface structures lying in Cameron, Clearfield, Indiana, Westmoreland, and Fayette counties in Pennsylvania, extending southwestward into Preston, Tucker, and Randolph counties in West Virgina have been known for many years, the rapid development of Onondaga chert and Oriskany sandstone gas possibilities had to await improved rotary drilling techniques to permit routine drilling to 8,000 feet or deeper.

Hydraulic fracturing of these formations generally has shown very good results, allowing a faster payout of productive wells. In addition, fracturing has enabled some wells that otherwise would have been dry holes to become producers after treatment. A good price structure for natural gas because of the proximity to eastern U. S. markets has also played an important part in this trend play.

**Some old fields in trend.** Production along this general trend began in Pennsylvania in 1920, with the discovery of gas in the Onondaga Chert at Mt. Pleasant, in Westmoreland County. Ten years later, three new Oriskany sandstone gas fields were found in Tioga County, Pennsylvania, and drilling throughout the remainder of the 1930s was generally concentrated in Potter County, where 12 new fields were found and developed before World War II, some of them overlapping the state line into western New York State, which also enjoyed vigorous Oriskany drilling. A very important gas discovery was made in Fayette County, Pennsylvania at Uniontown in 1937. But drilling continued to be concentrated in the north, where the Oriskany sandstone could be reached at shallower depths, approximating 3700 feet.

In adjoining West Virginia, more remote from markets, exploration proceeded slowly. The Davis field in Tucker County was discovered in 1944, followed by Terra Alta in Preston County in 1945, and Eglon in Preston, Pifer Mountain in Tucker, and Glady in Randolph, all during 1954.

With cable tool drilling still standard practice, a major gas field was found at Leidy in Clinton County, Pennsylvania, in 1950. The Driftwood-Benezette field was found with the East pool discovery in Cameron County in 1951, followed by West pool's discovery in Elk and Clearfield counties in 1953, which gave rise to a vigorous drilling race to develop the field that carried through most of 1954. These fields showed beyond question that major gas reserves could be expected in the Oriskany sandstone and Onondaga chert through a northwest-southeast trending region in western Pennsylvania.

By the end of 1957, Leidy gas field had produced 105 billion cubic feet of natural gas. The gas is essentially dry, high-methane, and averages about 1000 Btu. Of the gas produced, about 90 percent was sold for 25 cents per Mcf at the wellhead, and 10 percent at 27½ cents, the price that prevailed at Leidy after 1954. Thus, about $26.5 million in wellhead revenues had been realized by gas producers at Leidy by the end of 1957.

Chert development in the Onondaga limestone is erratic, and reservoir conditions in this formation, which includes vertical fractures in some fields where it produces gas, are generally unpredictable. Permeability and porosity in the Oriskany sandstone are also very irregular, owing largely to varying degrees of calcareous cementation of the sand. Thus, neither the Onondaga nor the Oriskany pays are subject to accurate reserve estimates using conventional engineering criteria. It has been found, however, that the Leidy field averages production of 7 MMcf per acre.

Like most Oriskany sandstone gas fields, Leidy will have a relatively short life. It has been largely depleted since 1954 and will be converted to gas storage. In December, 1957, an application was filed with the FPC by three companies for permission to develop Tamarack and Leidy fields as a $6,164,700 gas storage project. The three firms are Transcontinental Gas Pipe Line Corporation, New York State Natural Gas Corporation, and Texas Eastern Transmission Corporation.

However, there is an advantage in that almost any producing field in this trend should be convertible to gas storage in the future, so that additional revenues may be realized from the field even after it is depleted. Care should be exercised to complete development wells so that they will be suitable not only for immediate gas production but for storage operations in the future as well.

Original reserves of the Driftwood-Benezette field, the biggest find so far in this general trend, was estimated at between 250 and 290 billion cubic feet. This field covers about 43,000 acres in Cameron, Clearfield, and Elk counties. By the end of 1957, a total of 298 producing wells and 81 dry holes had been drilled at Driftwood-Benezette. It is estimated that

only 100 wells would have been necessary to drain the field, but overly competitive drilling of small tracts represented not only an over-all waste of materials, labor, and money, but may have caused a reduction in the recoverable gas from state lands where accepted standards of well-spacing and conservation were generally observed. The problem of small tracts continues to be a problem in Pennsylvania, where there is no law requiring unitization for purposes of producing natural gas. About the only thing a prudent operator can do about it is to attempt to lease large blocks wherever possible, and avoid small tracts.

The big Appalachian structures being tested along this trend are as long as 30 miles parallel to their generally northeast-southwest trending axes. Most of them are faulted, very often thrust-faulted. There is considerable effective closure. There is well over 300 feet of structural relief at the Oriskany level indicated by producing intervals in wells at Driftwood-Benezette. A less spectacular producing anticline, Nolo in Indiana County, Pennsylvania, appears to have about 470 feet of effective closure at the Oriskany level. At Nolo, there were eight producers with an aggregate initial open flow of 13,500 Mcf in January, 1958, plus two dry holes. Proven gas production appeared to extend for about 10 miles along the apparent faulted structure which is about 16 miles long on the surface, parallel to its axis.

At the same time, the most active field was at Chesnut Ridge, in Clearfield County. In January, 93 producers with an aggregate initial open flow of 508,000 Mcf had been completed, plus 16 dry holes. Fifteen new wells were being drilled. There was vigorous activity on the Jacksonville Dome, Indiana County, in January 1958. This structure was opened to gas production in 1956. Both the Onondaga chert and Oriskany sandstone are productive. There were eight wells at Jacksonville in various stages of drilling and completion at the start of 1958.

**Geology.** A general picture of the geology and drilling depths can be gained from Table 1, showing depths to the Oriskany sandstone and other information. The wells, taken more or less at random, are listed, running from northeast to southwest. They serve to show why the northernmost, shallowest part of this trend was drilled more densely first, with the deeper drilling to the southwest lagging behind and becoming more intense now that air and gas drilling techniques have been sufficiently improved.

Economics, of course, played a part, because generally the farther north one finds production in the Appalachian region, the better the price. Prices range from about 20 cents per thousand cubic feet in northeastern West Virginia to over 32 cents in New York State. However, as greater reserves are proven to the southeast, the price structure should improve there also.

Generally, the Onondaga limestone thins to the northeast, and chert development, characteristic of the lower part of the Onondaga section, dies out to the northeast also. The thickness of the Oriskany sand increases considerably toward the southwest in West Virginia.

Due to erratic permeabilities in both the chert and Oriskany, some wells that were unproductive prior to fracture treatment have become commercial wells as a result of fracturing treatment. One chert well in the Mount Pleasant Field, Westmoreland County, showed a very small, initial gas flow, but after being fractured was gaged at 16 MMcf daily. One of the biggest wells in the trend ever recorded was one in the Uniontown Field, gaged at 40 MMcf per day, natural.

The structures tend to be faulted, and high-angle thrust faults are a particular problem. This is because when the well penetrates the fault, it has passed from the upthrown to the downthrown side, just the reverse of what occurs when the drill penetrates a normal fault. Some efforts are being made to determine the fault pattern in advance through the use of seismic data to chart structural shift in depth, but the fault patterns are very complicated and more intensive and widespread seismic studies need to be made before seismograph becomes an accurate detail tool in the Appalachian province. Velocities are high, reported in the order of 13,000 feet per second. Thus, only a slight change in velocities can cause a significant difference in calculated and actual depths to the Onondaga and Oriskany formations.

**Fracturing.** Hydraulic fracturing has been very effective, not only in bringing in wells that have missed permeable zones by short horizontal distances, but in enabling good wells to pay out even more rapidly. The use of water as the fracturing fluid has largely replaced kerosine, diesel fuel, oil and chemical products. Usually fracturing is done through 7-inch casing. One company reported uniformly poor results when it was routine practice to fracture through 2-inch tubing, but then got excellent results from fracturing through 7-inch casing.

**Drilling methods.** Under unusual and ideal conditions, it is possible to complete a rotary hole along this trend in three weeks if no difficulties are encountered, particularly if surface hole can be made rapidly with a rotary. However, it is considered standard practice to use cable tools to about 1,000 feet and set surface casing. At this depth, most of the water-bearing formations have been penetrated, and sufficient weight can be put on a rotary bit to penetrate the hard Appalachian formations at a satisfactory rate. Since the advent of air and gas drilling, one rotary bit made 2,400 feet of hole in 46 hours, which stood as a record in this area

**TABLE 1**

| WELL | Location and Elevation | Top of Onondaga | Top of Chert | Top of Oriskany | Initial Production |
|---|---|---|---|---|---|
| Felmont Oil Corporation Lena Lockwood 1 | Cattaraugus County, New York, eight miles north of Pennsylvania border. El 1,630 ft. | 3,674 ft. | no chert recorded | 3,754 ft. | 4.5 MMcf |
| New York State Natural Gas Corporation State 1, Tract 72 | Leidy Field, Stewartson Township, Potter County, Pennsylvania. El 1,977 feet | ..... | ..... | 6,796 ft. | 60 Mcf before frac. |
| Parsons, State 6, Tract 36 | Chestnut Ridge Field, Goshen Township, Clearfield County, Pennsylvania El 1,973 feet | 7,096 ft. | 7,114 ft. | 7,129 ft. | 500 Mcf before frac. 3,000 Mcf after frac. |
| Felmont Oil Corporation Bethlehem -Cuba Iron Mines 1 | Nolo Anticline, Indiana County, Pennsylvania El 2,014 feet | 8,103 ft. | 8,117 ft. | 8,216 ft. | 800 Mcf before frac 4300 Mcf after frac |
| Columbian Carbon Company United States of America G-1 | Blackwater Anticline, Randolph County, West Va. El 3448 ft. | 5,132 ft. | 5,171 ft. | 5,300 ft. | 4,225 Mcf before frac 9,962 Mcf after frac |

as of January, 1958. Ordinarily, five weeks is considered a satisfactory period for completing an Oriskany producer.

One company active in the trend has the following standard casing program:

30 feet of 13⅜-inch conductor string;

750-800 feet of 9⅝ surface string;

7-inch protection-production string at about 7,000 feet, run just after the top of the Onondaga limestone has been penetrated and identified.

The wells are generally drilled with air from the bottom of the surface string to the casing seat for the seven-inch. Then, the drilling fluid is changed over to gas for drilling through the Onondaga and Oriskany formations. It is desirable to avoid down-hole explosions which could be rather severe in the case of a big gas well being drilled in with air, particularly in the chert. If the well shows for gas, it is fractured through the seven-inch casing, and produced the same way. If it is a dry hole, the seven-inch can be readily salvaged, minus the bottom few joints which are cemented before the well is drilled in.

**Drilling and completion costs.** The average producing well in this trend costs approximately $100,000 to $115,000 to complete. A rotary-drilled dry hole would cost roughly $55,000 to $65,000. Crooked rotary holes are generally not a problem, despite hard rocks and high-angle faults.

**Terrain.** The ruggedness of the western Pennsylvania terrain is generally well enough known that it is not necessary to go into it in much detail here. Generally, the terrain becomes more rugged, with decreasing accessibility southward into West Virginia. Drilling operations are proceeding in Blackwater Falls State Park, near Davis, W. Va. According to the Appalachian Geological Society, this locality was once described as an area "so savage and inaccessible that it has rarely been penetrated, even by the most adventurous. The settlers on its borders speak of it with a sort of dread, and regard it as an ill-omened region filled with bears, panthers, impassable laurel brakes and dangerous precipices." Air-drilling, formation fracturing, and increased demand for natural gas are helping to modify this description considerably. —**The End**

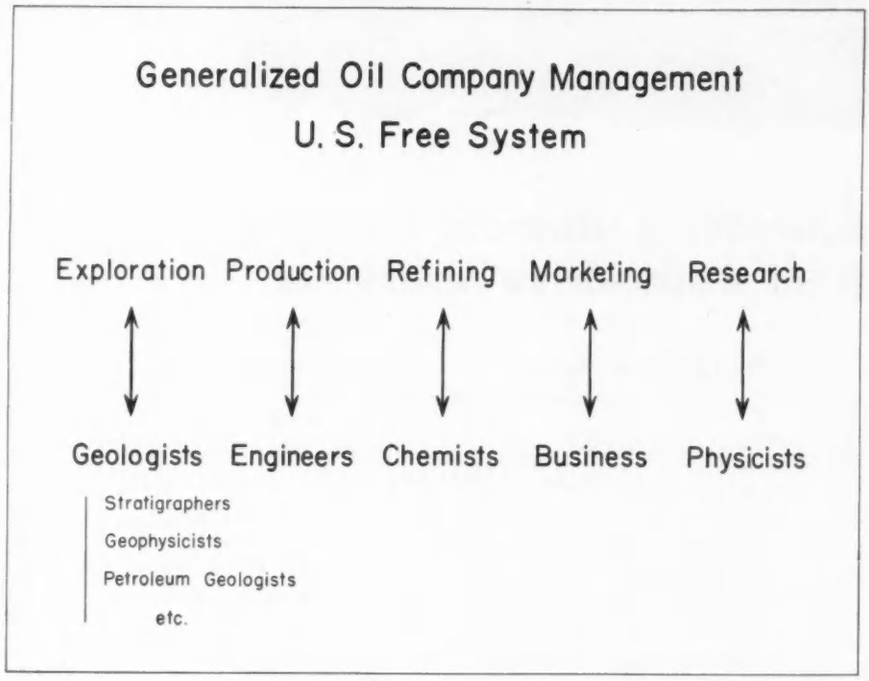



**FIGURE 9—Shows the manner in which the average generalized oil company management has developed in America. The physicists run research; the businessman, marketing; the chemist, refining, and the geologist, exploration.**

the oil is located. It is the interpretation and prediction that are most important.

Consequently, there is no use in keeping geologists and geophysicists separate. The umbrella term is geology—"logic of the rocks"—and the geophysicist is a physicist only in a narrow sense.

Top management of many U. S. oil companies is in the hands of men with geological training. Perhaps this could be traced to two general causes:

**1.** The discovery of a continuing supply of oil and gas is basic to most every company as well as to the oil industry as a whole. This is the chief concern of the geologist. Exploration is becoming so complex that no one but a geologist knows for what the exploration money is spent—and even he may be in doubt!

**2.** The geologist is continually dealing with variables. His prediction must be made on scanty data and dependent on judgment and experience. His problems are not those that can be solved by a slide rule. In this respect the geologist is fitted for the role of management where judgment and experience are of prime importance, and where most of the problems are defined by variables.

**Example.** The Mid-Continent is an example of what might be termed the "American System" of finding the oil. It is at one end of the oil-finding spectrum. At the other end are the monopolistic countries where the government owns the petroleum and does all of the exploration. Between are all combinations of ownership, exploration controls, concessions and organizational set-ups. But nowhere is exploration so consistently successful in discovering new pools as in the Mid-Continent.

Perhaps because of the surplus of oil in the U. S. and the consequent poor economics, many U. S. oil companies are entering foreign exploration or are considering it seriously. Many geologists are being sent abroad, and the promise seems to be that these are but the beginning. After all, we now can explore virgin territory throughout much of the world with 1957 technology. What more can a geologist wish for? The training available in the Mid-Continent is as good, if not better, than any other place in the world. And Mid-Continent-trained geologists are doing some of the best exploration that is going on anywhere.

—**The End**

For Your PRODUCTION File

PART 3

# Estimating ultimate recovery from water-drive reservoirs

**By FRANK W. COLE,** School of Petroleum Engineering
University of Oklahoma, Norman, Okla.

THIS TECHNIQUE requires that the position of the oil-water contact at some time after substantial volumes of oil have been produced be known, as well as the original oil-water contact. Normally, there will be a sufficient number of wells at various structural levels in the reservoir to estimate reliably the water-oil contact at any time by use of individual well production data. Ultimate oil recovery is then calculated by the following equation:

$$\text{Ultimate Oil Recovery} = \text{Expansion Oil Recovery} + \text{Water-Drive Recovery} \quad (1)$$

In most active water-drive reservoirs, reservoir pressure will continually decrease. This reduction in reservoir pressure per unit of oil production will be less for active water-drive reservoirs than for other types of reservoir driving forces. If original reservoir pressure is well above saturation pressure, any pressure reduction will cause expansion of all of the oil in the reservoir. The amount of this oil expansion can be calculated when relative volumes of the oil at different pressures is known.

If the reservoir contains a gas cap, the original reservoir pressure will be equal to the saturation pressure. In this case, there will be no expansion oil recovery. Expansion or shrinkage of the gas cap then will have some effect on ultimate recovery. These factors have been discussed previously in another series.

Water drive oil recovery (the second term in Equation 1) can be estimated as follows:

$$\text{Water Drive Recovery} = \frac{\text{Acre-Ft. in Oil Zone} \times \text{Adjusted Cum. Oil Prod.}}{\text{Acre-Ft. of Oil Zone Invaded By Water}} \quad (2)$$

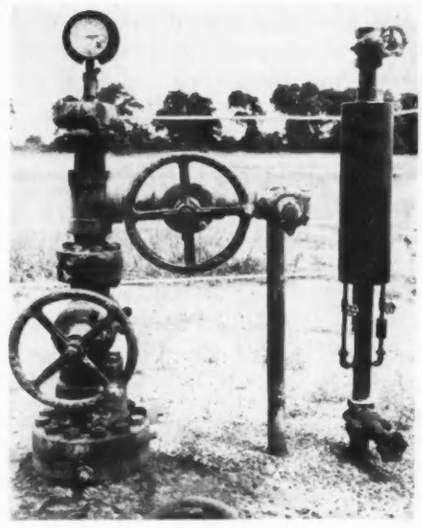
Where:

A. Adjusted cumulative oil production is equal to the cumulative oil production less the oil production attributable to oil expansion.

B. Acre-feet of oil zone invaded by water if found by knowing the oil-water contact at any time and thereby determining the number of acre feet of reservoir flooded by the rise in oil-water contact.

Stated very simply, Equation (2) determines the efficiency of water drive during displacement from a portion of a reservoir. It then assumes that this displacing efficiency will prevail during the entire water drive process.

TO BE CONTINUED



## Easy-to-Make Lubricator Is Operated by Gravity

The lubricator illustrated is mounted on the flow line at the well site. It may be used to introduce paraffin solvent, corrosion inhibitor or emulsion breaking compounds into the well stream. No power source is required since the device operates by gravity feed.

A junk piece of 5½-inch casing is used to construct the chemical reservoir. Steel plate is welded on both ends of the casing forming a completely closed cylinder. A hole is cut in the top plate, and a 2-inch coupling is welded into place as shown. Two ¼-inch holes are cut in the bottom plate of the cylinder and ¼-inch couplings welded into place.

A short length of 2-inch pipe is welded to the bottom plate with ¼-inch connections as shown. This lowermost piece of 2-inch pipe does not directly connect with the reservoir but is welded to the bottom steel plate. The 2-inch pipe is then stabbed into the flow line riser and the ¼ x ¼-inch connection work completed. An additional 2-inch nipple and valve are required at the top of the reservoir for an effective seal. Chemical to fill the reservoir is introduced through this top valve.

The ¼-inch piping shown is equipped with a check valve. The globe valve on the "check" side is opened and pressure is equalized between the flowline and the reservoir.

*See pages 44-59 for other Practical Operating Hints*

# Gas injectivity profile logging is successful

**Location of gas entry into a formation can be accurately determined by obtaining an injectivity profile.**

**By Richard H. Widmyer**
The Texas Company
Bellaire, Texas

GOOD RESULTS have recently been obtained by using gas injectivity profile logging techniques as a means of locating points of gas entry into gas input well formations. The method, similar to that used in water injectivity profile surveys, has yielded extremely interesting and accurate downhole information.

In 1955, a technique for obtaining injectivity profiles in water input wells was introduced to the oil industry.[1] The method uses a weak radioactive solution to determine accurately the location of water entry into a formation. The considerable number of successful water injectivity profile surveys which have been conducted suggested that the same technique could also be applied to the determination of injectivity profiles for gas input wells.

The technique presented here is very similar to that used in the aforementioned water injectivity profile surveys, i.e., a weak radioactive solution is used to identify one of two injection streams entering the well. Figure 1 is a schematic illustration of this method. It is observed that one of the streams is fed into the tubing and the other into the annulus with the bottom of the tubing being positioned below the lowest zone of interest. In this illustration, the annulus stream contains the radioactive tracer. It is observed that gas in the radioactive annulus stream leaves the well bore above the depth where the annulus stream meets the non-radioactive gas stream from the tubing. The depth in the well bore where the two streams meet at any specific rate setting, or the interface of radioactive-nonradioactive gases, is established by running a small gamma ray logging sonde in the tubing. Rates of injection of the two streams are controlled by valves or regulators located at the surface. For best results, the combined rates of the two streams are kept at the same total, preferably at the well's normal injection rate.

An injectivity profile is built up by a systematic adjustment of relative rates and location of the resulting interface with a gamma ray detector.

In the example shown in Figure 1, a total constant gas injection rate of

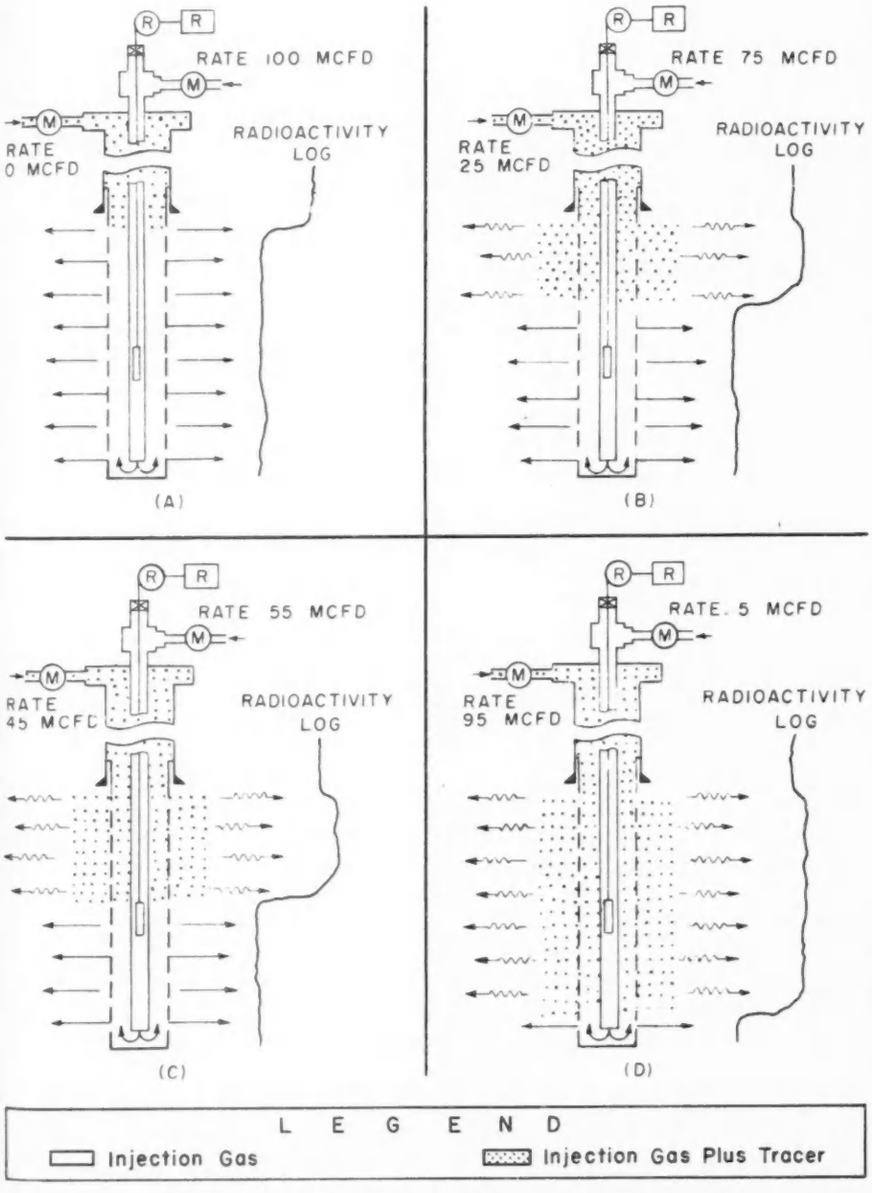



**FIGURE 1—These schematic drawings show the procedures required to run a gas injectivity profile survey by means of the Texas Company's radioactive interface technique.**

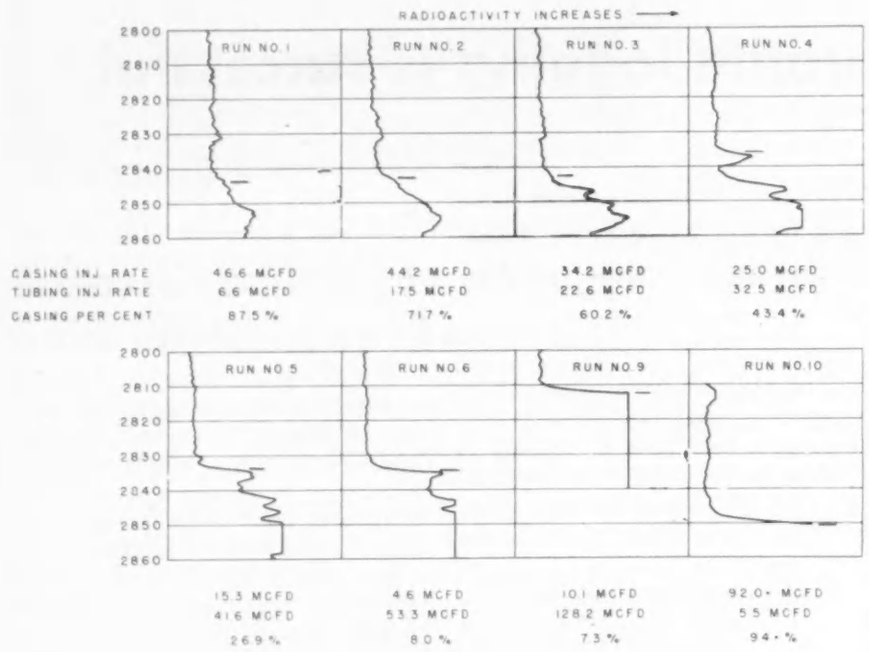
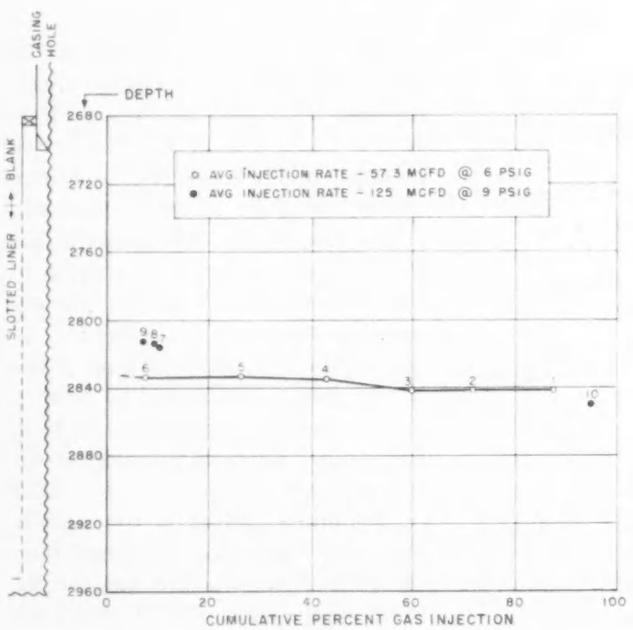



**FIGURE 2—A series of interface logs obtained during the course of surveying a typical gas injection well are shown. In this example, the tubing stream contained the tracer. It is observed that the interface moves up the well bore as the survey progresses. This is a result of initiating the survey with low tubing and high annulus rates. The interface pick points are shown and the ease with which they may be determined is apparent. It is noted that the character of the log below the interface is largely due to variations in the concentration of $I_{131}$ in the well bore. The interface location is determined by picking the point where the radioactive gas in the annulus causes the first deviation from the background log.**

100 Mcfd was used, this being the sum of the rates of radioactive gas in the annulus and nonradioactive gas in the tubing. Initially the nonradioactive gas present in the annulus above the injection interval is displaced with radioactive gas. As soon as the displacement is ascertained (by detecting the leading edge of the radioactive interface near the top of the injection zone), the rates are adjusted so that no radioactive gas is being injected into the annulus. Nonradioactive gas is then injected into the tubing at the total rate (100 Mcfd). After a short period of time, any radioactive gas which might have accumulated opposite the receptive section of the formation will be displaced by the nonradioactive gas being injected through the tubing. A radioactivity log is then run. By comparing this log with a natural radioactivity log run prior to the introduction of radioactive gas, the lowest point of radioactivity increase indicates the radioactive-nonradioactive interface. The depth above which no gas is leaving the well bore is thus determined. This situation is illustrated in Plat A of Figure 1.

Depending on the concentration of radioactive material in the annulus



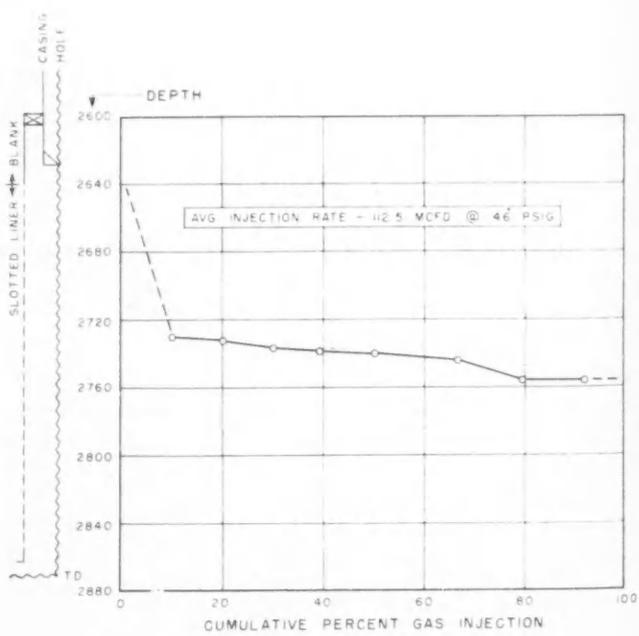




**FIGURE 3—This illustration shows the injection profile obtained from the survey logs of Figure 2. The various log runs and rate precentages are numbered on each figure to facilitate comparison. From the profile it is observed that most of the gas injection is confined to the middle 11 percent of the intended injection interval of 232 feet. This is illustrated by rate percentage points 1 through 6. Following this survey, the total gas injection rate was increased 120 percent with little change noted in the distribution of the injected gas as shown by points 7 through 10. In order to obtain point 10, it was necessary to displace or purge the radioactive gas from the injection interval above. The ease with which this was accomplished is apparent by comparing log runs 9 and 10 of Figure 2.**

**FIGURE 4—This gas injectivity profile was made on a well which is offset to the wells described in Figures 3 and 5. Note that gas injection is again confined to the middle 11 percent of the intended injection interval.**

# Gas distribution in input wells . . . is likely far from ideal

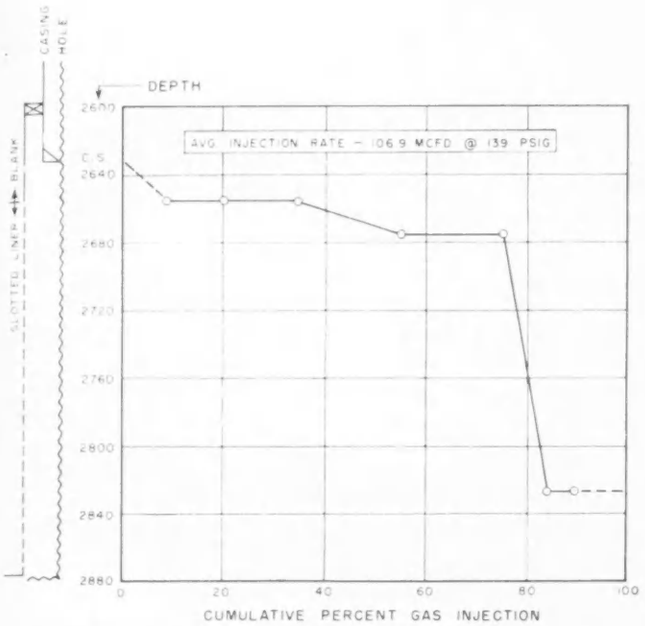



FIGURE 5—(Above) The survey of this well (offset to those profiled in Figures 3a and 4) shows that between 30 percent and 55 percent of the gas is entering the formation through the top of the slotted liner. From the amount of radioactivity buildup in the interval 2632-35 feet observed during the survey, it is probable that a considerable amount of the gas going out at the top of liner is entering this interval. At least 75 percent and possibly up to 84 percent of the gas was found to be leaving the slotted liner above 2675 feet with the balance entering the formation at approximately 2826 feet. This represents an actual injection interval of approximately 44 feet, or 18 percent of an intended injection interval of 247 feet.

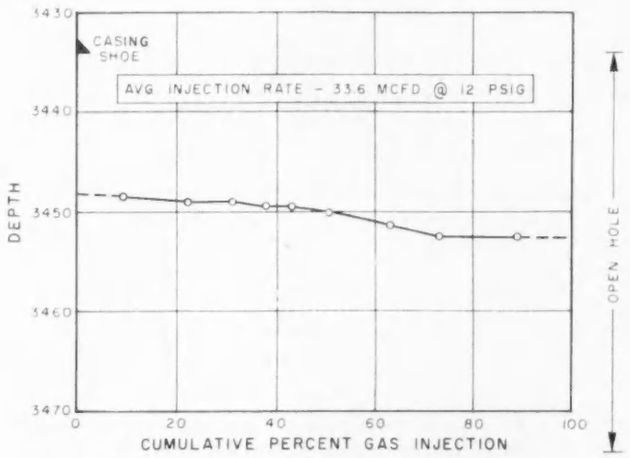



FIGURE 6—This profile of a well in another area indicates that only 7 percent of the 40 foot open hole interval is receptive to gas at the survey injection rate. Injection is limited to the middle of the completion interval.

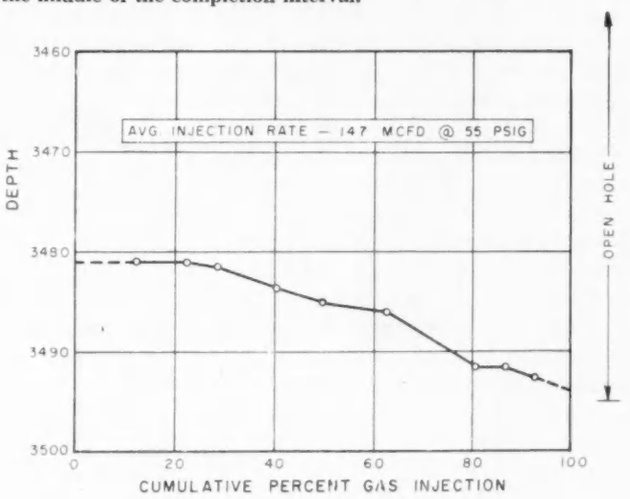



FIGURE 7—(At right) This profile is from a well offset to that shown in Figure 6. In this case, gas injection was confined to the lower third of the 40-foot intended injection interval.

gas, and the present state of the zone of interest regarding a possible previous radioactivity contamination, the point of increase in radioactivity over the natural background may be sharp enough so that comparison with the natural gamma ray log is unnecessary.

As the relative rate of radioactive gas entering the annulus to nonradioactive gas entering the tubing is increased, more of the permeable zone will be exposed to the injection of radioactive gas, thereby moving the interface downward. As the relative rates are changed by increments, depth location of the interface is found by the radioactivity detector. Plat B of Figure 1 illustrates this movement of the interface by changing the injection rates to 25 Mcfd of radioactive gas in the annulus and 75 Mcfd of nonradioactive gas in the tubing.

The zone located between the interfaces shown in Plat A and Plat B, is taking gas at the rate of 25 Mcfd, or 25 percent of the total injected gas.

Plat C illustrates further movement of the interface by changing the injection rates to 45 Mcfd of radioactive gas in the annulus and 55 Mcfd of nonradioactive gas in the tubing. The zone located between the interfaces shown in Plats B and C is taking gas at the rate of 20 Mcfd, or 20 percent of the total injected gas.

Plat D illustrates the position of the interface with injection rates of 95 Mcfd of radioactive gas in the annulus and 5 Mcfd of nonradioactive gas in the tubing.

From Figure 1 it is readily apparent that an accurate injection profile can be made regardless of whether the injection gas is leaving uniformly over the whole zone, or is confined

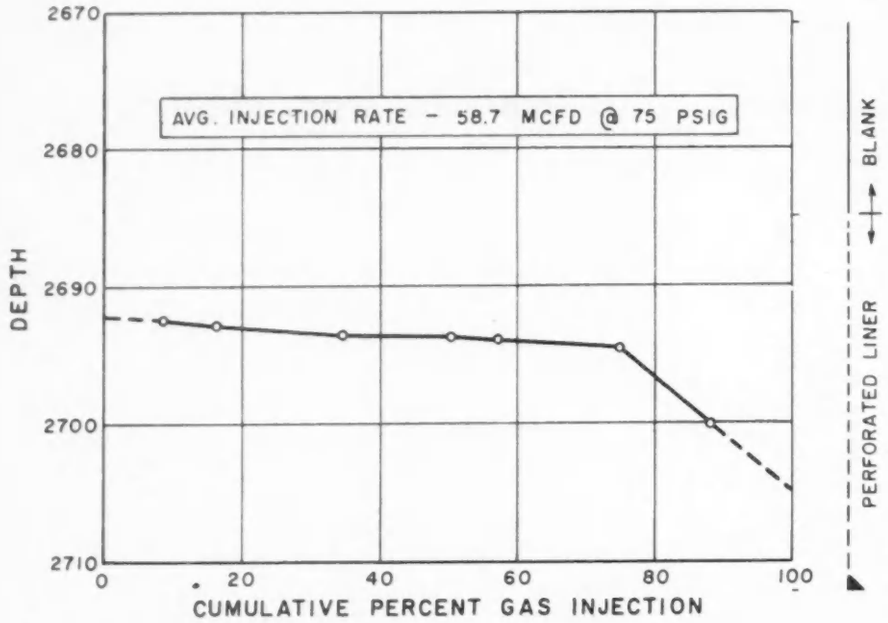



**FIGURE 8—This injectivity profile was obtained from a well in a third area. It is observed that 75 percent of the injected gas is entering only 2 or 3 feet, or approximately 10 percent, of the 24 feet of intended injection interval.**

to a short interval. It is also apparent that the bottom of the tubing should be placed below the bottom of the injection zone. If gas is leaving the well bore below the lower end of the tubing and the annulus stream rate is great enough to exceed the formation injectivity above that point, the two streams will co-mingle and no sharp interface can be detected below the point where gas leaves the tubing.

Figure 1 is purely illustrative, and if conditions permit, the tubing stream can be made radioactive and the annulus stream nonradioactive.

A few inherent advantages of this technique are:

- The detecting instrument is run in the tubing resulting in a desirable undisturbed interface. There is also much less chance of losing instrument in tubing than if it were run in the annulus.
- Tubing need not be pulled if it is originally positioned, or can be easily reset, below the lowermost zone of interest. The presence of a packer is not a detriment, if by unseating the packer, annular communication can be established.
- The system can be used in cased or open holes.
- No knowledge of borehole diameter is required since the location of a vertically stable interface is all that is needed. Since only the qualitative presence of increased radioactivity is necessary, no downhole quantitative measurements of gamma ray intensity are required.
- Very small depth increments can be used since the radioactive-nonradioactive interface is quite sharp and can be located easily within a one foot interval. The limiting factor in the accuracy of a survey is the resolving power of surface meters and regulators.
- On one survey, it is possible to obtain an injectivity profile of the injection zone, check the casing for leaks, check all cement jobs, and evaluate remedial work previously performed on the well.
- No elaborate well preparation or equipment is required. The survey can usually be conducted in a few hours at reasonable cost, with little interruption in the injection process.
- The radioactive gas can be flushed from the immediate vicinity of the injection interval. This makes it possible to run as many injectivity profiles as needed in the course of remedial work, to plot intermediate points or to replot any point that is uncertain.

Iodine-131 in the form of ethyl iodide is a suitable radioactive tracer. It is readily available and reasonably priced. The eight-day half-life is desirable since it does not leave the gas or formation permanently contaminated.

Figures 2 through 8 are examples of various gas injectivity profiles obtained from several different fields. Each of the surveys was conducted at the well's normal injection rate.

The injectivity profiles shown in the illustrations are typical of the gas input wells surveyed to date. The gas distribution is generally very poor when considered in terms of percent of injection interval intended or available. This suggests that gas distribution in many gas input wells is far from ideal.

Although the number of gas injection wells in the country is considerably less than the number of water injection wells, the actual per well need for this type of survey and the subsequent appropriate remedial work appears to be much greater. Follow-up surveys can be performed to determine the effectivenes of remedial efforts to improve the gas distribution.

It is concluded that the radioactive interface technique can be used to determine the injection profile of a gas input well with the same high degree of accuracy presently available with water injectivity profile surveys using this technique.

ACKNOWLEDGMENT

The author wishes to express his appreciation to the management of The Texas Company for permission to have this report published and to the co-workers and field personnel without whose cooperation these results would not have been possible.

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**About the Author**

**Richard H. Widmyer** was graduated from Ohio State University in 1949, with a B.S. degree in Mining Engineering, Petroleum Option. He has worked for The Texas Company since 1949, as a field, reservior and research engineer. He is presently a research engineer engaged in log evaluation and interpretation work in the Bellaire Laboratory, Research and Production Research Division.

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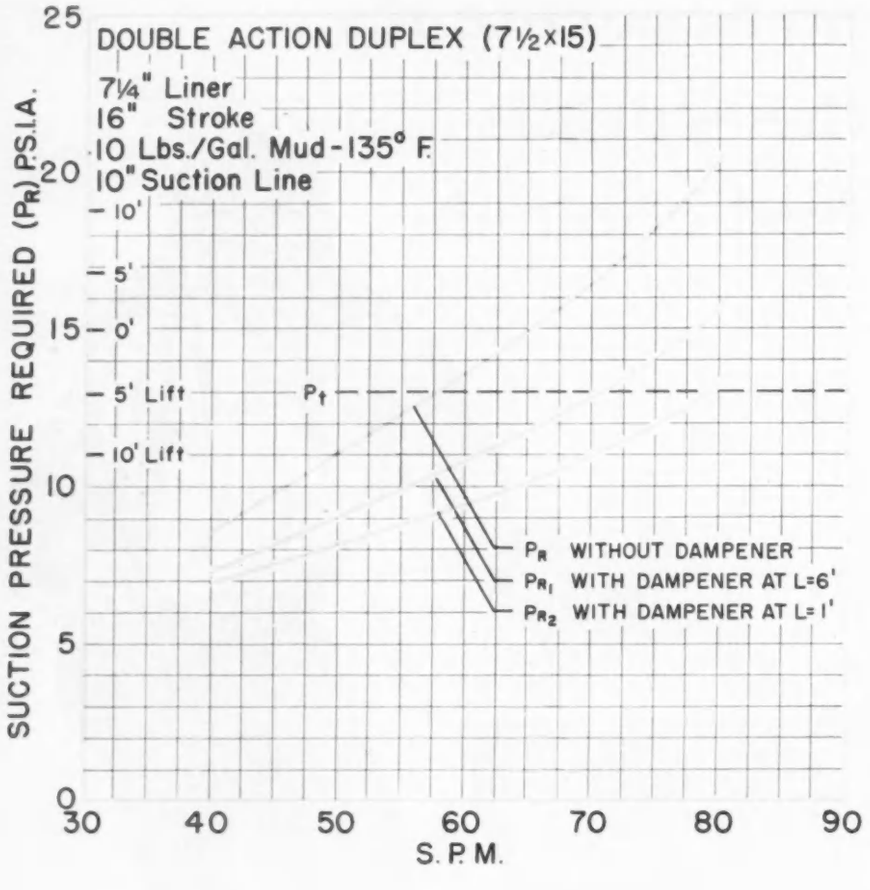


FIGURE 11—These curves show the suction line pressure required ($P_R$) without a dampener and with the dampener placed six feet and one foot from the suction flange. Total pressure available for filling (assuming five-foot lift) under the 3 conditions is noted with the dotted line ($P_t$). Note the higher speeds that may be obtained with a dampener placed close to the suction flange.

PART 3: SUCTION DAMPENERS

# Know your mud pump—it can save you money

**Suction dampeners, whether shopmade or commercial can help smooth pump operation, reduce pressure requirements, and prevent knock.**

**By Samuel L. Collier and Carl Aalund**
Mission Manufacturing Company, Houston

THE SEVERE DEMANDS for higher mud pressures and volumes placed on the pumping equipment by modern drilling practices make it mandatory for the contractor to design and apply the right equipment. A simple device, such as a suction dampener, can help. With a dampener, improved pumping characteristics can be expected on any type reciprocating simplex, duplex or triplex pump. A commercial dampener and several shopmade dampeners were tested under controlled conditions for knock prevention and effectiveness of surge removal. The conclusions reached are based on tests run on a double-acting duplex pump using electronic transducers and a high frequency recording system.

A suction dampener will not increase the horsepower of a pump, but it can help utilize more of the horsepower that was built into it. A dampener does this by increasing the speed at which the pump can run without the problems of knocking and accompanying pressure surges. The extra speed advantage is the basic reason for the use of a dampener, but other advantages are:

1. Stabilizes pressures in the suction line.
2. Allows use of longer suction lines or smaller diameter lines.

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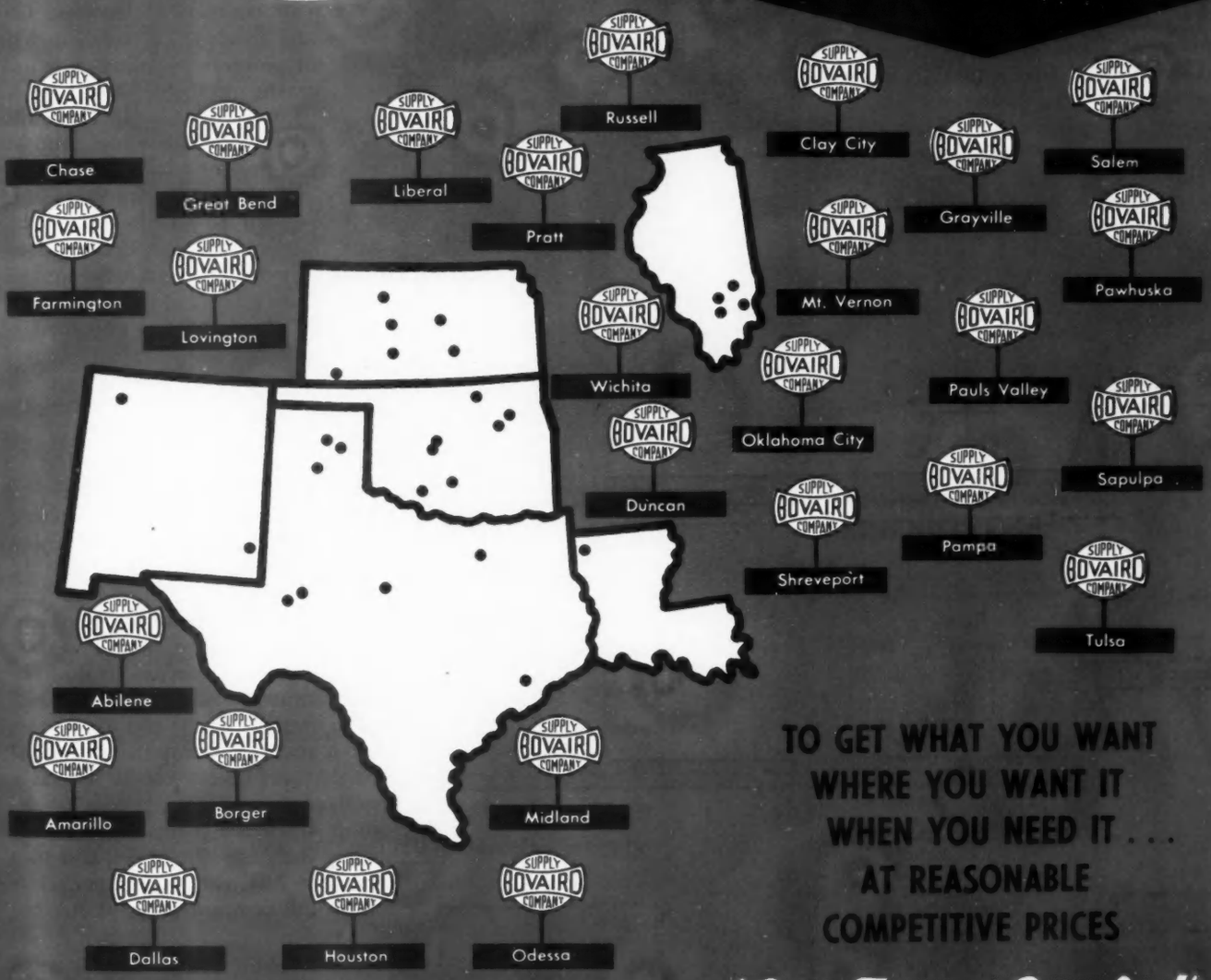


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The previous article of this series pointed out the relationship of suction pressure requirements to pump speed for a double acting duplex mud pump. This relationship was applied to obtain a curve of required suction pressure vs. strokes per minute. A similar curve, Figure 11, is included in this article for a double acting duplex pump with and without a dampener. A suction dampener will lower the suction line pressure required, at a given pump speed, to maintain good filling.

By comparing the curves for a pump with and without a dampener, it may be seen that with a given suction pressure, or head, available, a higher pump speed can be supported with a dampener than without. The reduction in pressure requirements made possible by the dampener can be used to run the pump at a normal speed and using heavier mud, or by using a longer or smaller diameter suction line. Any one of these factors will increase the suction pressure required to pump at a given speed without knocking and severe pressure surges. Also, a substantial change in any of these factors can completely erase the advantages gained by a dampener.

The advantages of a dampener add up to more flexibility of present equipment and increases in parts life. Parts life is directly related to the loads or pressures occurring in the pump. This will be covered in a future article of this series.

There are some drawbacks in the use of a dampener:

1. Higher original pump cost.
2. Extra maintenance (some types).
3. Priming necessary when starting the pump (some types).

There is a maximum pump speed above which a dampener will not prevent knocking and pressure surges.

In most cases where the installation of a dampener will be considered the suction system of the pump has already been designed and built, and rebuilding of the suction system is not easy or practical. When designing a suction system, the use of a dampener should give extra pump performance and not have to be used to obtain normal expected performance.

A dampener can be very simple and small, but an understanding of its functions should be considered before the application or construction of a dampener is discussed.

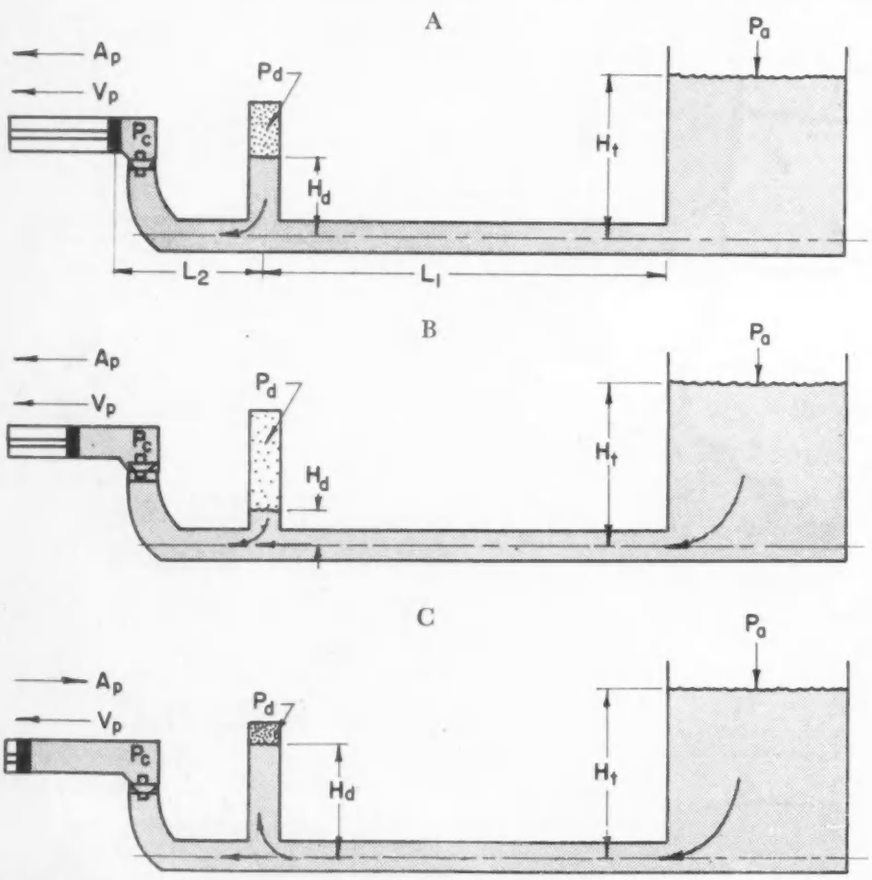


**FIGURE 12—Illustrated are the three major steps in a dampener's operation. The nomenclature used in the drawing is:**
**$a_p$—Acceleration of piston**
**$V_p$—Velocity of piston**
**$P_c$—Cylinder pressure**
**$P_d$—Dampener pressure**
**$P_a$—Atmospheric pressure**
**$L_1$—Pipe length from the dampener to the cylinder**
**$L_2$—Pipe length from the dampener to the mud tank**
**$H_t$—Height of mud in the tank**
**$H_d$—Height of mud in the dampener**

**How a dampener works.** The input power of a mud pump is transferred directly from the flywheel through the gears and crank to the piston. All connections between the piston and flywheel are rigid, and if sufficient power is supplied to maintain constant speed, the piston moves approximately with simple harmonic motion. For good filling, the mud in the suction line must follow the piston precisely. The mud in the suction line, therefore, will be subjected to the same accelerations and decelerations as the piston. Forces must be applied to the mud to give it these accelerations and decelerations. The mud is not rigidly connected to the piston; therefore, the mud must depend on the force resulting from the difference in pressures acting on the ends of the suction line for its acceleration.

Since in most cases the pressure on the pit end of the line is atmospheric and is a constant pressure, the cylinder pressure must drop to achieve the required pressure difference to give the mud its acceleration. Accordingly, at the end of a stroke, the piston must apply the force necessary to slow the mud down. It is at these two points, at the start and at the end of a stroke, that a suction dampener does the greatest part of its job. It acts as a small reservoir of mud close to the pump which the pump can draw on during the start of a stroke, and then acts as a cushioning air pocket to absorb the pressure surge at the end of a stroke.

The second article of this series pointed out that at the end of a stroke and at the start of a stroke the velocity of the piston is zero, but that the acceleration and deceleration of the piston are maximum at the start and end of a stroke respectively. The speed of the pump determines how large these accelerations are, and in turn how large a pressure differ-

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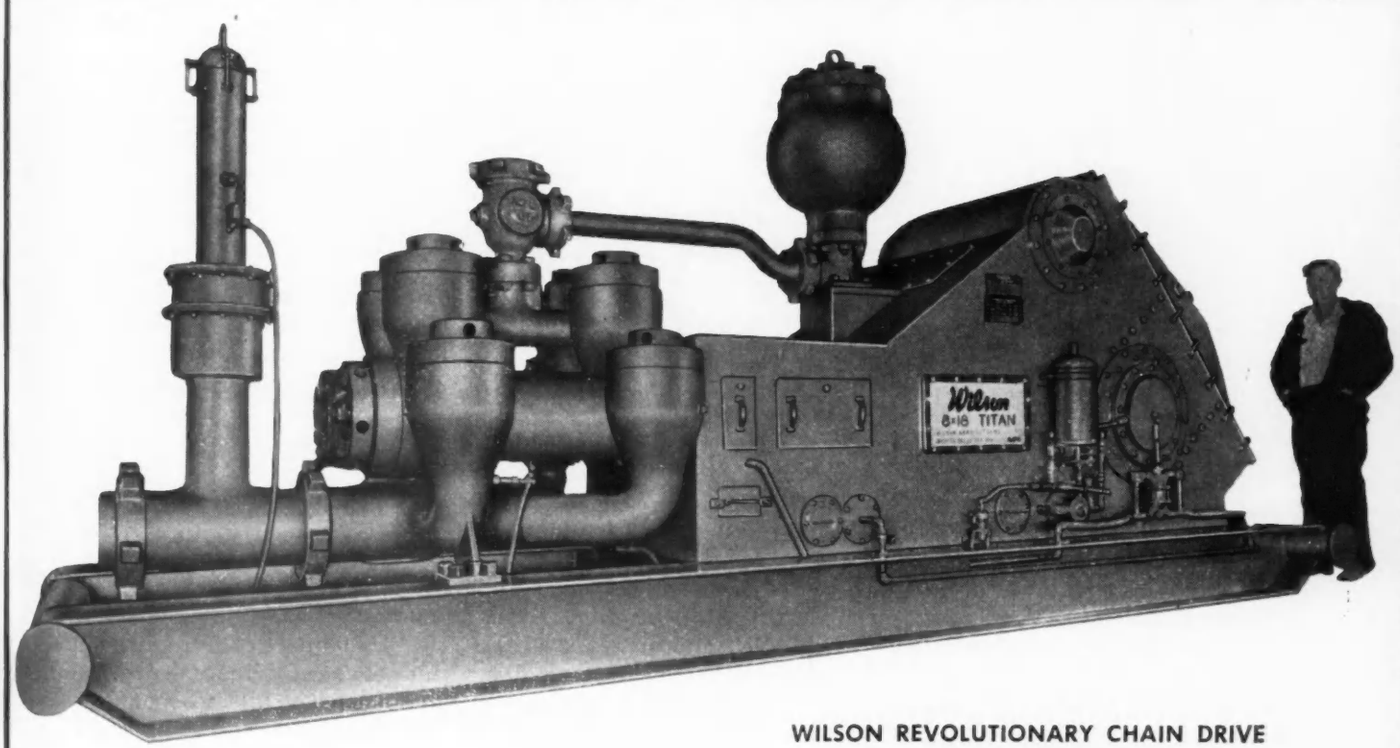


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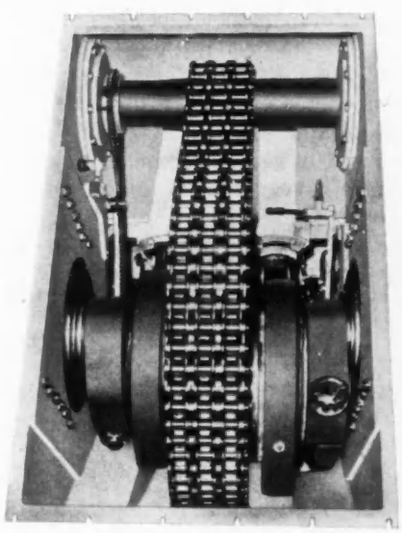

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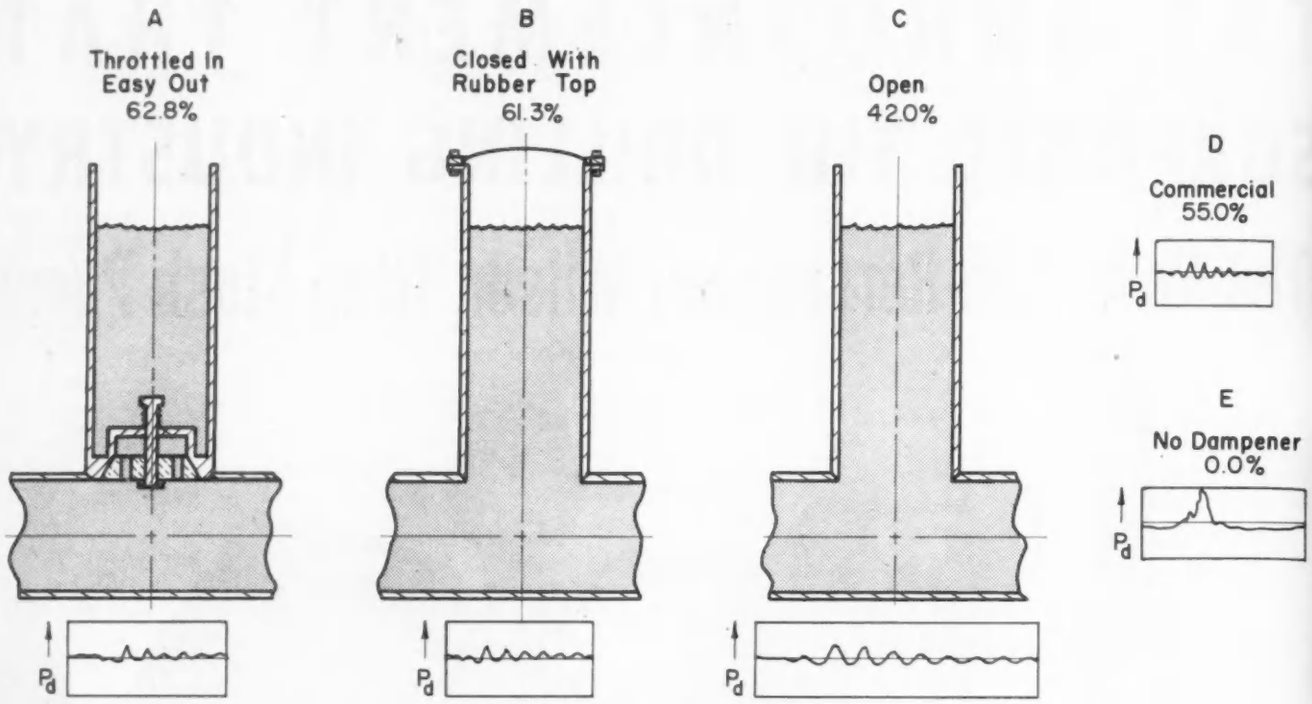



**FIGURE 13—Ocillograph records and percent effectiveness of three shop-made dampeners and a commercial dampener are compared against record obtained without a dampener. Note that almost any type of dampener will reduce dampening by 50 percent.**

ence will be required between the ends of the suction line to give the mud the necessary acceleration to follow the piston. The total weight of mud in the suction line that must be accelerated toward the pump at the start of a stroke will also affect the pressure difference that is necessary to maintain good filling. The total weight of mud moved in the suction line is determined by the mud density and the length and diameter of the suction line.

Figure 12 shows the three major phases a dampener goes through during a single suction stroke.

The operation of this air-chamber type dampener is typical of most other types of dampeners. At the start of a stroke when the acceleration ($a_p$) is high, the pressure in the cylinder ($P_c$) starts to drop to give the pressure difference that is required to accelerate the mud in the line. Instead of obtaining mud from the mud tank, mud is taken from the dampener (Figure 12a). The pressure in the dampener ($P_d$) forces mud out into the low pressure suction line. The mud is taken from the dampener because this is the source of least resistance. If the flow were taken from the tank all the mud in the suction line from the pump to the tank would have to be accelerated, whereas with the dampener only a short section of the suction line is accelerated. When the pressure in the dampener drops below the pressure at the tank, mud will start to flow from the mud tank also (Figure 12b). As the stroke progresses the high acceleration required of the mud in the suction line, by the piston, falls off. The pressure in the dampener drops until only a small amount of the total flow is drawn from the dampener. This shift in source of flow from the dampener to the mud tank is a smooth change which eliminates the sudden pressure drop which would occur if the mud had been taken directly from the mud tank.

Toward the end of the stroke, the piston is slowing down and a pressure from the deceleration of the mud builds up behind it. At this time the dampener starts to operate in reverse. Instead of the piston supplying a high force, resulting in a high suction pressure, to slow all the mud in the suction line, it supplies only that force which is required to slow the

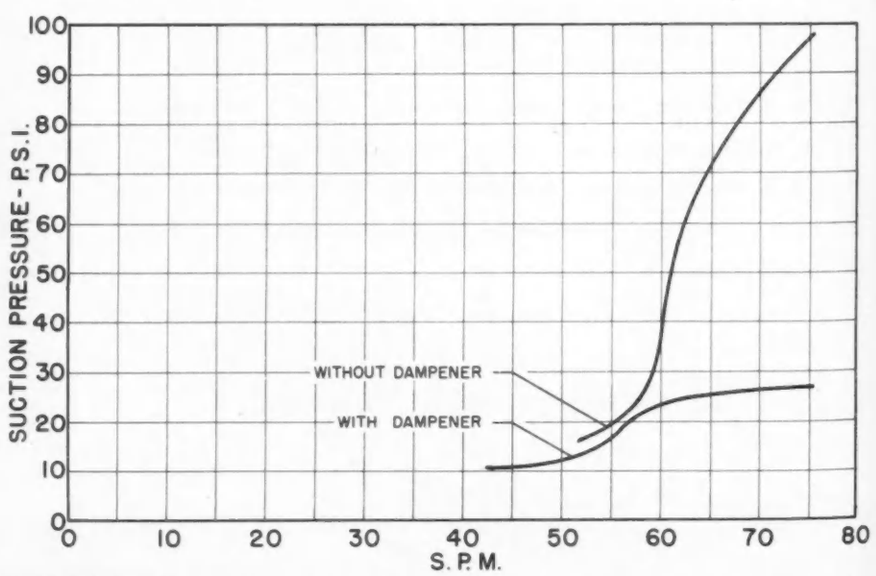
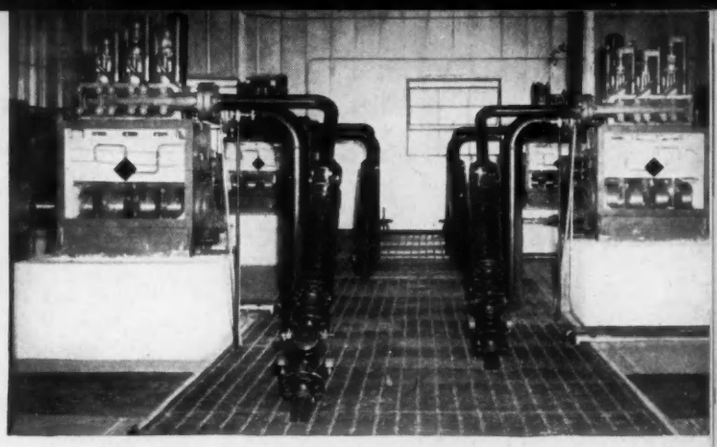
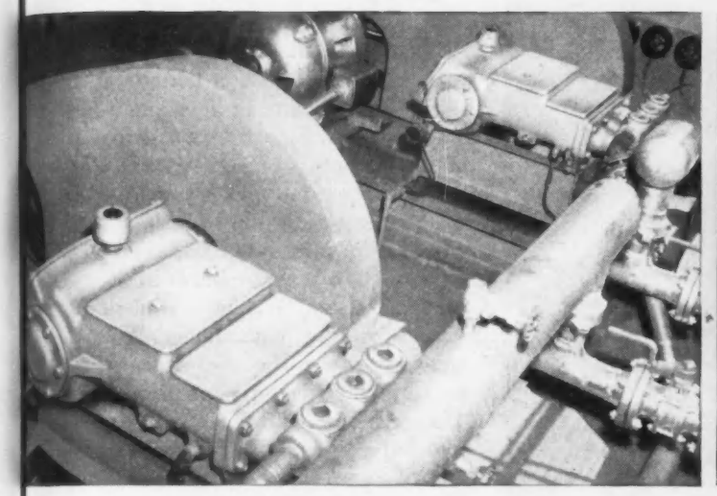



**FIGURE 14—In this curve of maximum suction pressure vs. pump speed, note the sudden increase in pressure at 59 strokes per minute. It is at this point that the pump will start to knock.**

Bethlehem designed and turnkeyed this waterflooding installation in West Texas.



Installation of four vertical high-pressure water-injection pumps.



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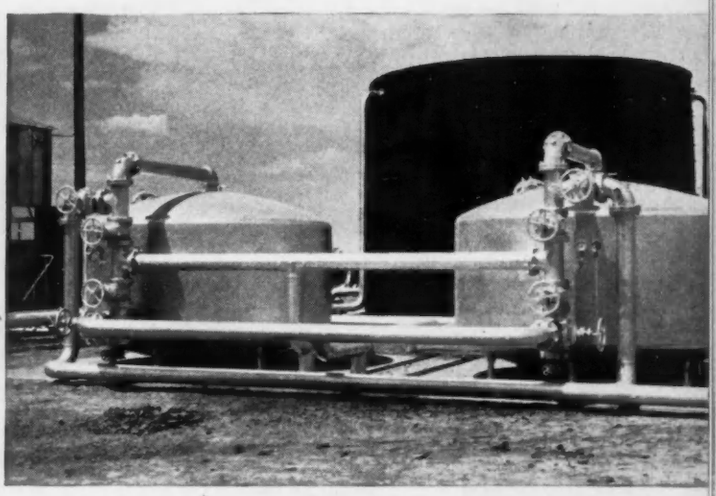

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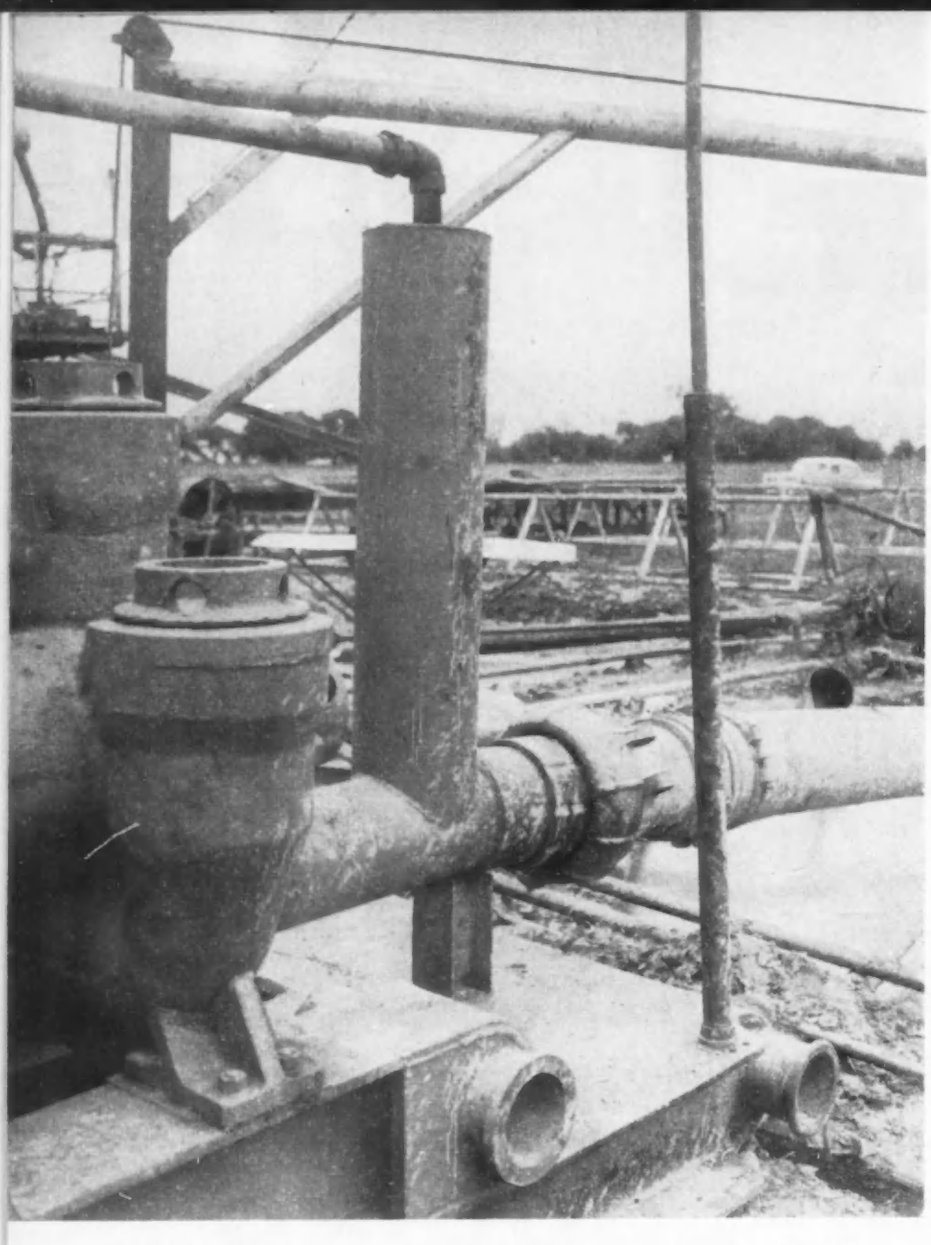


**FIGURE 15—A typical shop-made suction dampener in use in the field.**

section of mud between the piston and the dampener. The mud in the remainder of the suction line is allowed to rise in the dampener against the air pressure in the dampener. The energy of the mud moving in the suction line is absorbed by the fluid rise in the suction dampener against a low pressure, thus reducing any pressure surge (Figure 12c).

During this third phase of a dampener's operation, energy has been stored in the dampener. As the pumping cycle repeats this stored energy is used to help the next suction stroke.

Figure 13 shows a variety of dampeners and the oscillograph records their suction pressure used on double acting duplex 7½ x 14 mud pump. The pump was pumping 10 pounds per gallon mud with a 5½-inch liner at 60 spm. Figures 13A, B, C, are records of the suction pressure with three different shop-made dampeners on the suction at 60 spm. Figure 13D is a record taken with a commercial type dampener. Figure 13E is a record of the suction pressure at 65 spm with no dampener. The pump had a slight knock at this speed. The pressure peak in Figure 13E is 98 psi. This surge was a result of a hydraulic knock in the pump. In other tests peaks in the suction pressure during a knock have been recorded as high as 180 psi. Little difference was noticed in the surge removal effectiveness of the dampeners tested, as shown in the similarity of the records in Figure 13. The relative effectiveness of each dampener to reduce the surge at the end of a stroke is listed with each record. This valve is the percent reduction in pressure rise allowed by the dampener at 60 spm as compared to the surge that would occur in the suction line without a dampener at the same speed. The results were good with each type.

An ordinary pressure gage can be used to observe the pressure variations in the suction with and without a dampener. The usual method of measuring pressures that are fluxuating rapidly is to install a snubber before a pressure gage and read the average pressure. This is inadequate in determining the real pressures existing in a suction line. The pressure, although difficult to read from a gage, without a snubber, is a better indication of the pressure in the suction line. The curves in Figure 14 are the maximum pressures picked up by electronic pressure pickups at various speeds with and without a dampener. There is a rapid increase in maximum suction pressure between 59 and 61 spm on a 7½ x 14 double-acting duplex without a dampener. This increase in pressure occurs at the speed at which the pump starts to knock. There is little difference between the two curves before this speed or prior to the knocking speed of the pump. The dampener's effectiveness is very high after the knocking speed is exceeded. This is not due to the dampener's ability to damp or absorb a surge, but is a result of the dampener's ability to prevent the development of a knocking condition.

The effectiveness of a suction dampener to remove surges should not be used as the only basis for selecting a dampener since a dampener's ability to prevent knock at high speeds is of greater importance.

**Field application.** The pump in Figure 15 shows a good example of a field application of a shop-made dampener. The results obtained in a field test of this dampener are described below:

The following values will be used to calculate the effectiveness of the dampener application on this pump.

Mud Temperature = 135° F.

(G) Mud weight = 10 ppg
($L_2$) Suction line length = 17 feet
($D_p$) Piston Size = 7¼-inch
(S) Stroke = 16-inch
($L_1$) Distance from dampener to flange = 6 feet
($H_p$) Height of mud in pit = minus 5 feet
($D_s$) Suction line diameter = 10-inch

## . . . Dampener installed on pump section reduces pressure requirements

The total pressure available ($P_t$) at the end of the suction line must be determined first. Since suction is taken from a pit the lift must be subtracted from atmospheric pressure to obtain the absolute pressure at the end of the suction line. $P_t = 15$ psi minus 2 psi = 13 psi (5 ft. of 10 ppg mud is equivalent to 2 psi).

Assuming 60 spm the suction pressure required ($P_r$) without a dampener can be calculated and then compared to the total suction pressure available. Using equation $E_1$ Part 2 to obtain piston acceleration.

$A_p = 0.000456\ N^2\ S$
$A_p = 0.000456\ (60)^2 \times 16$
$A_p = 26.30\ ft/sec^2$

The pressure required for mud acceleration in the suction pipe is obtained by using equation $E_2$ Part 2.

$$P_s = 0.001978\ LG \left(\frac{D_p}{D_s}\right)^2 A_p$$

$$P_s = (0.001978)\ (17)\ (10) \left(\frac{7.25}{10}\right)^2 (26.30)$$

$P_s = 4.64$ psia

At 135° F. the vapor pressure of water is 2.50 psia. To prevent boiling the pressure in the suction line must not drop below the vapor pressure of the mud, therefore 2.50 psia must be added to the pressure required. The friction losses in the suction line are negligible in this case, therefore the total miscellaneous pressure losses $P_m$ will be 2.5 psi. Another pressure loss, pump losses, ($P_p$), for this pump operating at 60 spm may be taken as 6.5 psia. This figure was determined by tests run on a 16″ stroke pump. The loss was found to be within .5 psi of the pump loss of a 14″ stroke pump. The manifold design of the pump will change the pump loss but the 6.5 psi figure is typical for most pump manifolds.

The sum of the various partial pressure requirements is the pressure ($P_r$) that must be present at the end of the suction line for good filling.

| | |
|---|---|
| 1. ($P_s$) Pressure to accelerate mud in suction line | — 4.64 psi |
| 2. ($P_p$) Pressure for pump loss | — 6.5 psi |
| 3. ($P_m$) Miscellaneous pressure | — 2.50 psi |
| 4. ($P_r$) Total pressure required | 13.64 psia |

The pressure available was found to be 13 psia. This shows a .64 psi deficit in suction pressure, and as a result the pump would have developed a knock at this speed, 60 spm. Figure 11 shows the suction pressure required for good filling at all speeds from 30 to 80 spm for this pump without a dampener.

With a dampener installed on the pump the suction pressure requirements are reduced. The reduction in pressure will depend on the height of mud in the dampener and, the distance the dampener is located from the suction flange. The calculations for the pressure required are similar to those for the pump without the dampener with the exception that instead of a value of 17 feet for L in equation E2, 7 feet will be substituted, since the dampener is located 6 feet from the pump suction flange and; there is 1 foot of mud inside the dampener. This substitution is possible since, referring to Figure 12, only that portion of the suction line between the pump suction flange and the height of mud inside the dampener must be accelerated at the start of a stroke; whereas without the dampener the total length of the suction line must be accelerated. The pressure required for mud acceleration with a dampener is:

$$P_s = 0.01978\ (7)\ (10) \left(\frac{7.25}{10}\right)^2 \quad (26.30)$$

$P_s = 1.91$ psia

The new figure for suction pressure requirements is 7/17 of the previous figure calculated without a dampener. The new total pressure ($P_r$) required is:

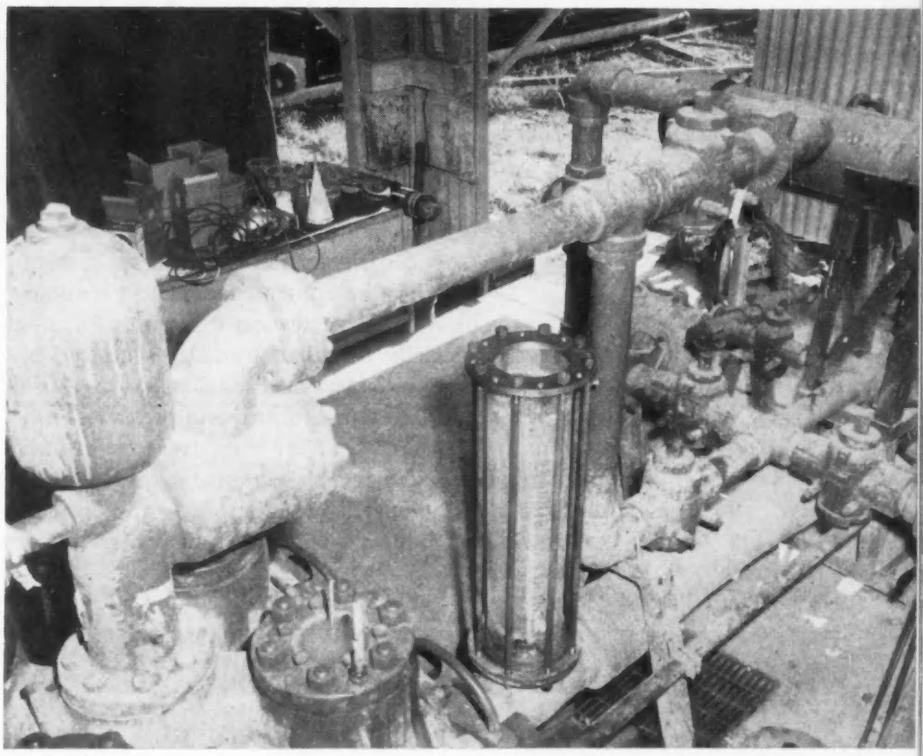


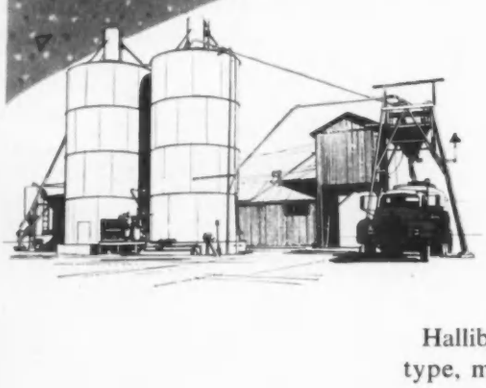
**FIGURE 16—In this dampener test conducted in a test laboratory, a plastic cylinder, open at the top, was used, so that the fluid action in the dampener could be observed.**

| | |
|---|---|
| 1. Pressure to accelerate mud in suction line | — 1.91 psi |
| 2. Pressure for pump loss | — 6.50 psi |
| 3. Miscellaneous pressure | — 2.50 psia |
| 5. Total pressure required | 10.90 psi |

If the dampener had been mounted 1 foot from the pump suction flange the pressure to accelerate mud in the suction line would be reduced to 2/17 of that required without a dampener. The acceleration in the dampener would be very high if a small line were used to connect the dampener to the suction line. The first dampener tried on this pump had a 2″ neck and failed to give satisfactory results.

Figure 11 also shows the curve of suction pressure requirements at vari-

# BULK CEMENTING



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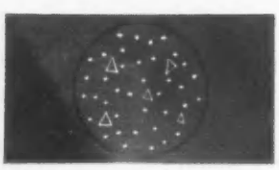

Gilsonite is a new additive used to lighten cement slurry weight down to 10 lb./gal. With a specific gravity almost as light as water (1.07), it adds volume but not weight to the slurry; setting characteristics are not appreciably affected . . . compressive strength is good. Due to its graded particle size, Gilsonite has very low fluid requirements: each 50 lbs. needs but 2 gals. of water. Will not take water from a slurry even under pressure. Unsurpassed for lost circulation or weak formation problems; much less Gilsonite Cement is required.

ous speeds for a 16-inch double-acting duplex pump with a dampener installed, 6 feet from the suction flange, and also a curve for a dampener located 1 foot from the suction flange. By comparing the two curves it can be seen that in this installation a 12-spm increase was realized with a dampener mounted 7 feet from the pump's suction flange and a 22-spm increase could be expected with a dampener 1 foot from the suction flange.

No attempt was made to account for the extra pressure stored in the dampener during the end of a previous stroke with an air chamber type dampener. This is a complex problem involving transient pressures and flows and is beyond the scope of this article. The curves in Figure 11 assume no energy or pressure storage in the dampener for use on the next stroke, but were drawn to give the minimum speed increase that could be realized with a dampener.

The ideal position of a dampener is at the pump suction flange which will give the maximum speed increase. This is equivalent to having the mud supply or tank at the mud pump's suction flange at the start of a stroke.

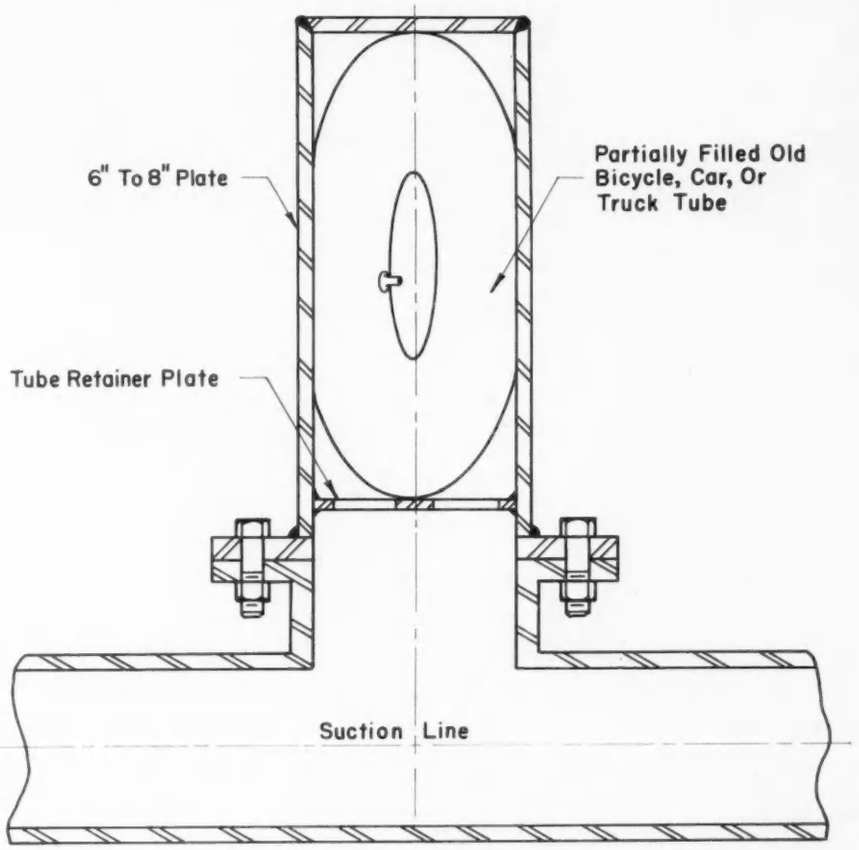


**FIGURE 17—A shop-made pre-charged dampener. The inner tube partially filled with air is a good means of precharging a dampener if water base muds are to be used. The rubber would deteriorate if used with oil or oil base muds.**

**How to construct a simple suction dampener.** Although there are some very good suction dampeners on the market, the dampener test results indicate the very simple homemade dampeners can be effective in preventing knock and pressure surges at increased pump speeds.

Of the various type dampeners, open, closed and combination restricted flow as shown in Figure 13, a compromise between effectiveness and simplicity is obtained with the closed type dampener.

There is one critical dimension in this type dampener. It is the inside diameter of the passage between the dampener and the suction line. This diameter should be as close to the suction line diameter as possible. The height of the dampener has a minor influence on performance. In the test run on dampeners a plastic tube Figure 16 was used for the housing of the dampener so fluid rise and fall inside the dampener could be observed. A fluctuation of mud level of approximately ¾ inch to 2 inches was noticed in the speed ranges that were checked with a 7½ x 14 pump. The air column or cushion above the fluid level was approximately 1 foot, therefore, the dampener need not be over 24 inches in height for the largest pump in the field.

A dampener may be installed in either the vertical or the horizontal position, but a self-contained air cushioning agent must be used if the dampener is to be installed in the horizontal position. A simple closed dampener with an air pocket trapped at the top must be installed in the vertical position to retain the air. There will also be a need for periodic recharging of the air pocket in the dampener due to air dissolving into the mud passing in and out the dampener. This can be achieved by a small petcock located on top of the dampener. If all the air were allowed to dissolve out of the top of the dampener it would not operate and the pump would operate as if no dampener were on the suction line.

Mounting a dampener with a self contained air supply in the horizontal or sidewise position is best from the operational standpoint since it would require no priming and would not interfere with pump maintenance. The self contained air cushioning agent can be any substance capable of changing its volume with slight changes in pressure.

An oil resisting air bladder would be necessary if oil base mud is used. A common automobile, truck or wheelbarrow innertube can be substituted if water base mud is used. The pressure in the tube or bladder should be just enough to fill it and no more. Figure 17 is a suggested design of a simple dampener. This type can be installed vertically, horizontally, or in any position as required. Sanding up of the dampener can be a problem in the horizontal position, but normal turbulence should keep the dampener clean.

The installation of a dampener is a cheap way to increase the speed of a mud pump and yet not suffer the consequences of knocking and pressure surges. Dampeners have been used in many other phases of pumping, and have proven quite effective. They are used on the discharge side of most pumps now in operation and should definitely be considered for the suction side.

**TO BE CONTINUED**

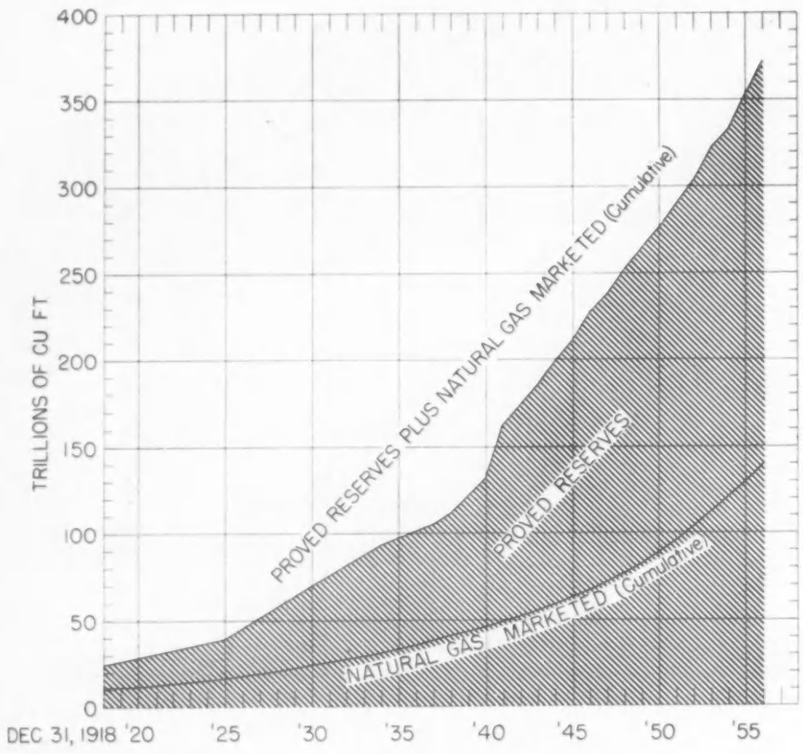


**FIGURE 1—Marketed and proved reserves of natural gas in the United States, 1918-1956. Production from U. S. Bureau of Mines; proved reserves from American Gas Association.**

# U. S. can long supply growing gas demand

**• U. S. consumption of natural gas likely will rise to 19 trillion cubic feet in 1975 from the current rate of 10 trillion feet per year.**

**• Operators probably can continue to meet demand from domestic supplies for over a decade and possibly for several decades.**

**By Ralph L. Miller,** Chief, Fuels Branch
U. S. Geological Survey, Washington, D.C.

FURTHER LARGE expansion of natural gas consumption in the U. S. is indicated for the next few decades. The gas will be readily marketed because of its abundance, ease of transportation, relatively low cost, cleanliness and ease of utilization. From the current rate of 10 trillion cubic feet per year, consumption is conservatively expected to climb to 19 trillion feet by 1975.

While increased quantities of gas will be required, it is likely that the needs can be met through development of domestic supplies for a considerable number of years.

There is a limit to the quantity of natural gas beneath U. S. soil. Gas production inevitably must reach a peak and then decline. The peak probably cannot be delayed more than 40 or 50 years. But it probably will arrive later than a previously estimated 1970 date.

Ultimate U. S. reserves of natural gas probably will far exceed the estimates heretofore made. In the past, those making estimates consistently have underestimated nature's bounty and man's ingenuity in finding nature's store of gas.

The ultimate reserves of gas may be estimated at 1150 trillion to 1700 trillion cubic feet. These figures include past production of 137 trillion cubic feet, present proved reserves of 232 trillion feet, and yet to be discovered reserves of 784 trillion to 1331 trillion cubic feet. These estimates are justified on the basis of authoritative estimates of ultimate U. S. petroleum reserves of 200 billion to 300 billion barrels.

The large supplies of gas required will be found in the extensive areas of the country offering favorable possibilities. Especially important among the favorable areas will be the Continental Shelves. To find and develop the vast quantities of new gas reserves will require much work, ingenuity and courage.

Although domestic reserves will be able to meet demand for a long time, it will be feasible to supplement supplies with pipe line imports of gas from Canada, Mexico and other countries. It may become feasible also to bring in natural gas by ship, in liquefied form, from the Middle East and other foreign producing areas.

**Two Kinds of Reserves.** There are two kinds of natural gas reserves: *proved* reserves and *ultimate* reserves.

Proved reserves include only gas that has actually been proved up by drilling and that is known to be economically recoverable. Starting in 1946 a committee of the American Gas Association, made up of members from industry, has prepared an annual statement on the known, proved reserves as of December 31 of each year, based on reports submitted by a carefully organized system of local and regional committees.

Every estimate of proved reserves must be dated. It represents the

**PART 1**

amount of gas known and producible remaining in the ground as of the specified date after allowance has been made for the amount withdrawn and the amount added by new discoveries.

The term ultimate reserves includes all gas that might ultimately be produced. It comprises all past production, all present proved reserves, and all reserves to be discovered in the future. Ultimate reserves is a much broader and more philosophical category of reserves than proved reserves. It is immediately apparent that any estimate of ultimate reserves must be based on a series of general assumptions, and that the amount of gas included will necessarily vary according to these assumptions.

Estimates of proved reserves are calculated by various formulae based on Boyle's and Charles' laws, pressure decline curves, studies of porosity and permeability of the reservoir sands, and other well recognized physical and engineering principles. The amounts thus calculated are accurate within reasonable limits. But because of the innate conservatism of most estimators, the calculated amounts are likely to be too small rather than too large.

By contrast, estimates of ultimate reserves are based on theoretical considerations of the thickness and volume of marine sedimentary rocks, the record of past experience in drilling in such rocks, the gas-oil ratios at various depths, the trend in the rate of discovery of proved reserves, and other such factors. No special accuracy is claimed for estimates of ultimate reserves, and historically they have consistently been much too low.

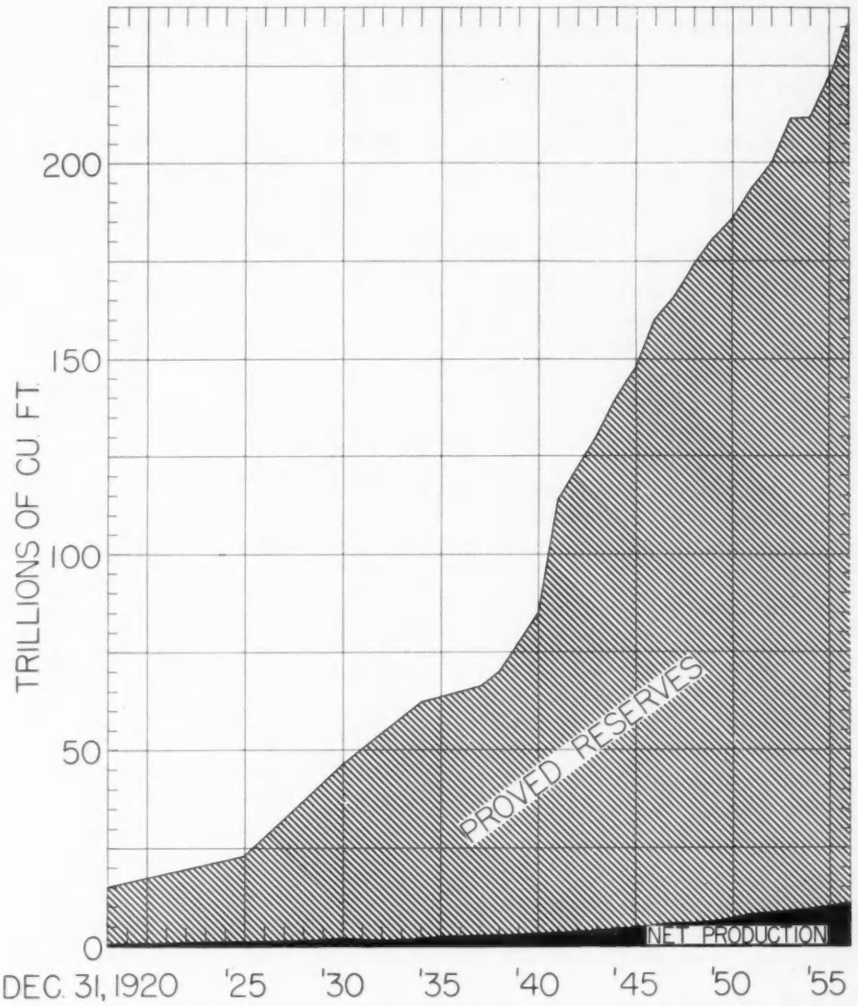


**FIGURE 2—Natural gas reserves and production in the United States, 1918-1956. Net marketed production from U. S. Bureau of Mines; proved reserves from American Gas Association.**

**The Past as a Key to the Future.** In considering natural gas reserves, present-day thinking, like that of the past, is largely conditioned by an existing technology. One cannot guess what surprises the future has to offer. But the experience of the past provides a partial measure of what might be expected in the future.

Consider past production and past estimates of proved reserves of natural gas in the U. S. The lower curve on Figure 1 shows past cumulative production of natural gas, with production of each year added to the accumulated production of previous years. The upper curve on Figure 1 shows calculated proved reserves at the end of individual years. The upper curve is added to the lower curve and thus provides the total of past production and the proved reserves for any selected year.

Figure 2 shows this same information so arranged as to emphasize annual production instead of cumulative production. This shows more graphically the vast quantities of proved reserves compared with annual production. It also shows how proved reserves have increased during the last 20 years—a rate that as yet shows no sign of leveling off.

It is interesting to review the history of past estimates of gas reserves in the U. S. In 1919 E. W. Shaw, a recognized authority of the day, predicted that the total recoverable and marketable reserves in both discovered and undiscovered pools were probably 5 to 15 trillion cubic feet. Today the U. S. is producing about that amount each year—something over 10 trillion cubic feet. Successive estimates, of course, have been higher. But the story has generally been the same. Every prognosticator has been completely discredited within a few years by the rapid advance of technology and by unexpected success in discovering new pools.

**Gas-Oil Discovery Ratios Have Increased.** Estimators of our natural gas potential have naturally assumed that the gas-oil discovery ratio as they knew it would continue. Thus in 1930 Huntley and Mason assumed, and logically, that the gas-oil ratio of 2250 cubic feet of gas discovered per barrel of oil of the previous 15 years could be projected safely into the future. Today, however, as we drill to depths that would then have been considered fantastic, we find a discovery ratio 7000 to 1, which is roughly three times as much gas per barrel of oil as could be estimated in 1930. Also, we have found oil and gas in types of

traps not experienced and recognized in the earlier days, such as the stratigraphic traps that are responsible for the East Texas and Pembina oil fields, and the facies change that has concentrated the gas in the great Hugoton gas field of Kansas, Oklahoma and Texas.

One generality can certainly be drawn from all past unsuccessful attempts to predict our ultimate oil and gas reserves. Man, for all his cleverness, has consistently been unable to visualize the diversity and the immensity of nature's reserves of mineral fuels, and has consistently underestimated his own ability to recover them from greater and greater depths and from structures completely hidden at the surface.

Even though we are taking vast quantities of gas from the earth every year, we have consistently been able to prove up even greater quantities each year. How long this trend can continue, no one knows. But we should be increasingly impressed with nature's bounty of natural gas and of man's ingenuity in finding it.

**Terry Estimate of 1950.** Perhaps the most widely publicized estimate of gas reserves in the U. S. is the figure of 510 trillion cubic feet prepared by L. F. Terry in 1950. His figure was for future recoverable reserves as of Jan. 1, 1950, not ultimate reserves as defined above.

This figure was arrived at by use of two simple and reasonable assumptions, as follows: 1. the ultimate petroleum reserves of the U. S. would be 110 billion barrels, as estimated by L. G. Weeks in 1947; and 2. the discovery and production of the future amounts of oil called for by the Weeks estimate would yield gas at the rate of 6000 cubic feet per barrel, which ratio had been established by drilling in the period prior to 1950.

At the beginning of 1950 the total past recorded production of natural gas had been about 78 trillion cubic feet. Terry's estimate of 510 trillion cubic feet of future reserves as of that date was, therefore, equivalent to an estimate of about 588, or roughly 600 trillion cubic feet of ultimate reserves. It is manifestly impossible to take into account the considerable quantities of gas wasted in the atmosphere in the early days of the industry, and such gas is not included in this or subsequent estimates.

**Larger Estimate of Gas Reserves.** Although these two estimates—one for ultimate petroleum reserves, the other for ultimate gas reserves—were prepared only a few years ago and were not questioned or disputed at the time, they are now known to be too conservative. An increase in the estimate of ultimate gas reserves in the U. S. is called for. The author would like to suggest an appropriate order of magnitude for a new estimate.

To start on this relatively uncharted path one must consider first the status of information available about petroleum reserves. Estimates of ultimate natural gas reserves in the U. S. are fixed firmly to estimates of ultimate petroleum reserves.

The period between 1950 and the present has witnessed tremendous activity and success in exploration for oil in the U. S. At the end of 1956, proved reserves of petroleum in the U. S., including the Continental Shelves, stood at 30.4 billion barrels, and past production totaled 55.2 billion barrels. This total of 85 billion barrels already produced or proved up by drilling shows the inadequacy of the Weeks ten-year-old estimate of 110 billion barrels for ultimate petroleum reserves. This figure would mean that if the current annual discovery rate were maintained for only about eight more years, all the remaining undiscovered oil in the U. S. would have been found. No one in the petroleum business believes this. All trends in production and discovery of oil are headed upward. There are constant improvements in recoverability. It has been obvious for several years that estimates of ultimate oil reserves must be increased significantly.

**Estimates of Oil Reserves.** In 1952, P. R. Schultz, reviewing the results of exploration to that date, concluded that ultimate reserves of petroleum in the land areas of the U. S. would be on the order of 170 billion barrels. He further concluded that prospects of improved secondary recovery plus new reserves on the Continental Shelves would justify raising the total estimate to 200 billion barrels. In 1953, Lewis MacNaughton, of the firm of DeGolyer and MacNaughton, also arrived at the figure of 200 billion barrels. In 1956, Wallace E. Pratt, in a report to The Panel on the Impact of the Peaceful Uses of Atomic Energy, a subcommittee of the Joint Committee on Atomic Energy, stated that we may reasonably expect to find another 100 billion barrels of new oil in the U. S. during the next 20 years.

At the same time, a group of geologists and engineers in the Interior Department reviewed the available data on this subject at the request of The Panel. They concluded that the experience in exploratory drilling to that date, plus the promise of greatly improved secondary recovery, plus the recent success of drilling on the Continental Shelves, justified the selection of an even higher figure of 300 billion barrels [Joint Committee on Atomic Energy, 1956 ("Impact" report), p. 82]. Qualified opinion therefore suggests that we may have ultimate reserves of petroleum in the U. S. in the range of 200 to 300 billion barrels.

Indeed, Paul D. Torrey, in discussing secondary recovery, stated in 1955 that in the U. S. we have already discovered 272 billion barrels of oil, though only about a third of it is economically recoverable by present methods. But as improved recovery techniques and increased economic incentives enable us to recover far greater quantities of this oil, it becomes apparent that the 300 billion barrel figure is not too far over the horizon.

Just as ultimate reserves of petroleum have been increased in recent years, so has the amount of gas discovered per barrel of oil. From a discovery ratio of 6000 cubic feet of gas per barrel of oil prior to 1950, the ratio is now in excess of 7000 cubic feet per barrel, and it is still headed upward. This trend is a natural and inevitable result of the trend toward deeper drilling. It is not likely to be reversed in the foreseeable future.

**Part 2 will appear in the October issue of WORLD OIL and contain a complete list of reference material.**

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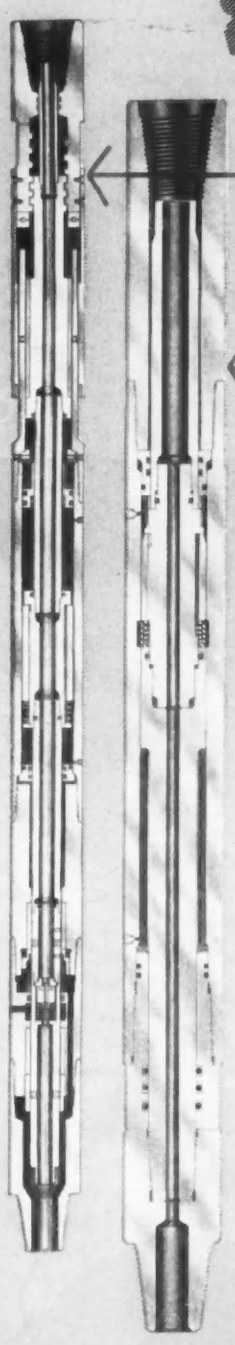

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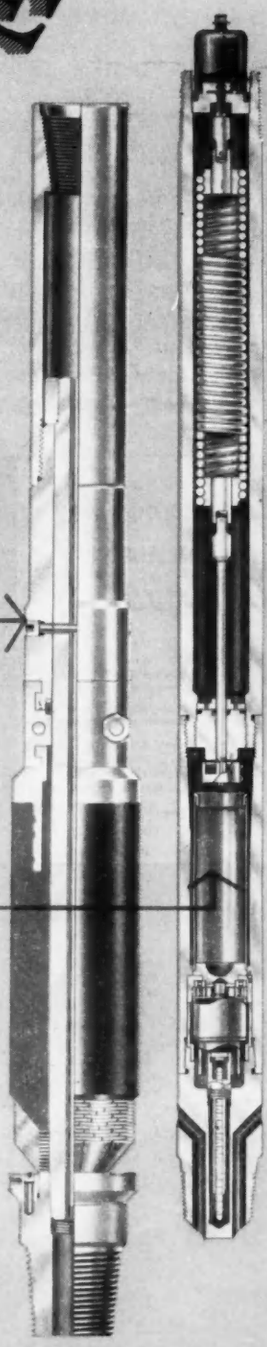

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# Haiti has good oil and gas possibilities

**Several basins are prospective oil areas. Drilling has yielded oil and gas shows. Geophysical and geological surveys offer encouragement.**

**By A. H. Wadsworth, Jr.,**
Consulting Geologist, Houston

ALONG WITH other Caribbean-Antillean republics, Haiti is attracting petroleum exploration efforts by major and independent operators. Development is encouraged by Haiti's friendly government. Exploration is impelled by the known existence of certain basin areas, favorable for petroleum accumulation, in the Ile d'Haiti or Hispanola, of which the Republic of Haiti occupies the western one third (Figure 1). The Dominican Republic occupies the eastern two thirds of the island (Figure 2).

The favorable basin areas in Haiti are under concession to the Commonwealth Oil Company, of Houston. With its associates, that company is actively engaged in geologic evaluation of the areas. Reconnaissance gravity and magnetic surveys have been completed. Photogeologic mapping of the basin areas is being

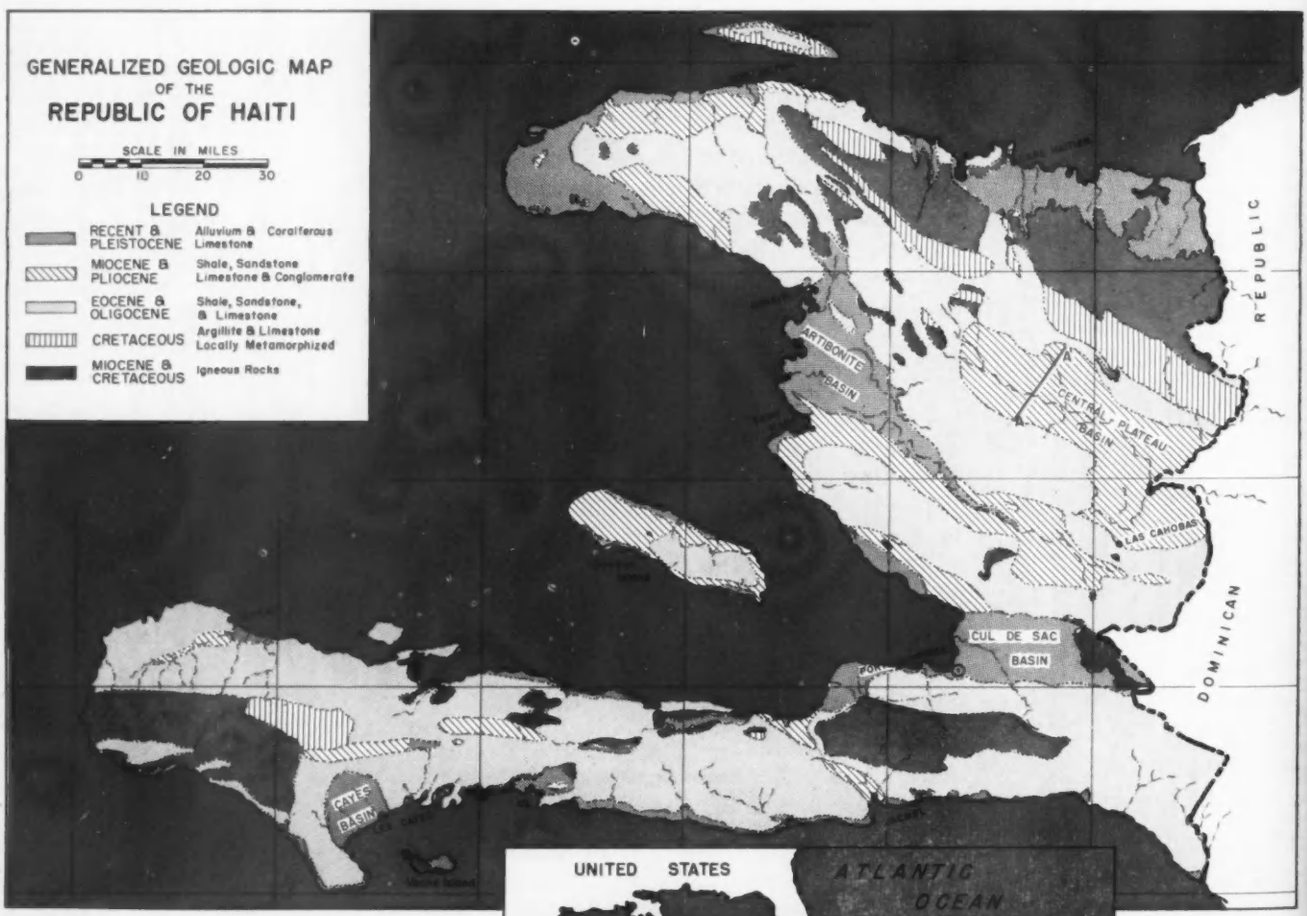


**FIGURE 1**—(Above) Four sedimentary basins in Haiti offer oil and gas possibilities. The line, A—A' across the Central Plateau basin shows the location of the cross section in Figure 3.

**FIGURE 2**—(Lower right) Haiti lies east of Cuba and north of the Colombia-Venezuela border. The Republic of Haiti covers the western third of the island of Hispanola and the Dominican Republic the eastern two thirds.

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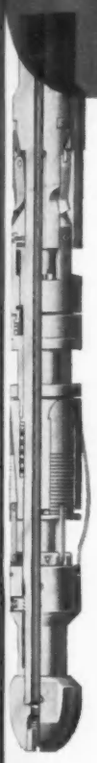

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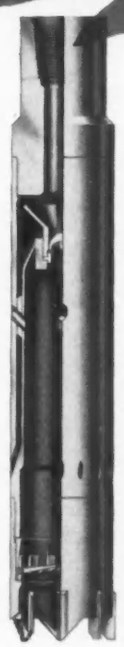

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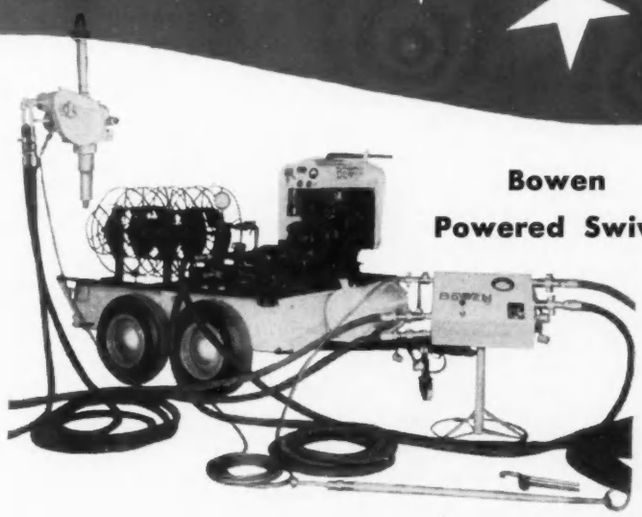

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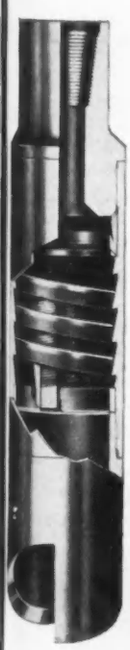

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## Numerous conditions favorable for oil accumlation exist . . .

conducted on recently taken aerial photographs. As a result of this work, several drillable prospects may be disclosed.

Earlier development work in Haiti has consisted of seven wells. Four were drilled on the mainland by The Atlantic Refining Company in 1944-1947. Three were drilled on the Ile d'Gonave in 1955-1956 by John Mecom, Commonwealth Oil Company, and M. E. Andrews.

Three of the four wells drilled by Atlantic on the mainland had shows of live oil in Miocene-Oligocene beds. One encountered a non-commercial accumulation of petroleum gas that flowed briefly under 300 pounds surface pressure. This show is believed to have been in Butterlin's Bassin Zim formation of Lower Oligocene age.

Several untested closed anticlines are known to exist in Haiti. And the wells heretofore drilled have not adequately tested the prospects that they explored.

An optimistic outlook for Haiti's petroleum possibilities is justified. There are numerous conditions favorable for the formation and accumulation of oil and gas in the republic. They include the following:

**1.** Thick sections of marine sediments aggregate approximately 26,000 feet.

**2.** Haiti has sedimentary facies favorable for the accumulation of oil or gas, i.e., sands intercalated with marine shale.

**3.** Favorable structures occur in marine basin areas.

**4.** Depositional environments could create stratigraphic traps.

**5.** Carbonaceous shales and marls carry shows of oil at outcrops.

**6.** Shows of oil or petroleum gas have been encountered in 3 of 4 wells drilled in the basin areas.

**7.** Confirmed oil and gas seeps exist in the Cul de Sac Basin of the Dominican Republic, about five miles from the Haitian border.

**8.** Small amounts of oil have been produced in related basins in the Dominican Republic.

**Geology.** Haiti's terrain is rugged, with mountain ranges of sharp definition and high relief, separated by relatively flat lowlands and closed basins. Steep slopes in the mountains often exceed 45 degrees and result in considerable areas of landslide topography. Climate is directly related to topography, and the wide variety of terrain produces a variety of climate and vegetation on the island. In the mountain ranges of the south and north, where rainfall is heaviest, forest growths of pine, mahogany, mangoe, campeche, etc., are common. It never freezes in Haiti, but the mountains are generally cool. In sharp contrast, the lowland areas are marked by far less rainfall, and in some areas a semidesert climate and xerophytic vegetation prevail.

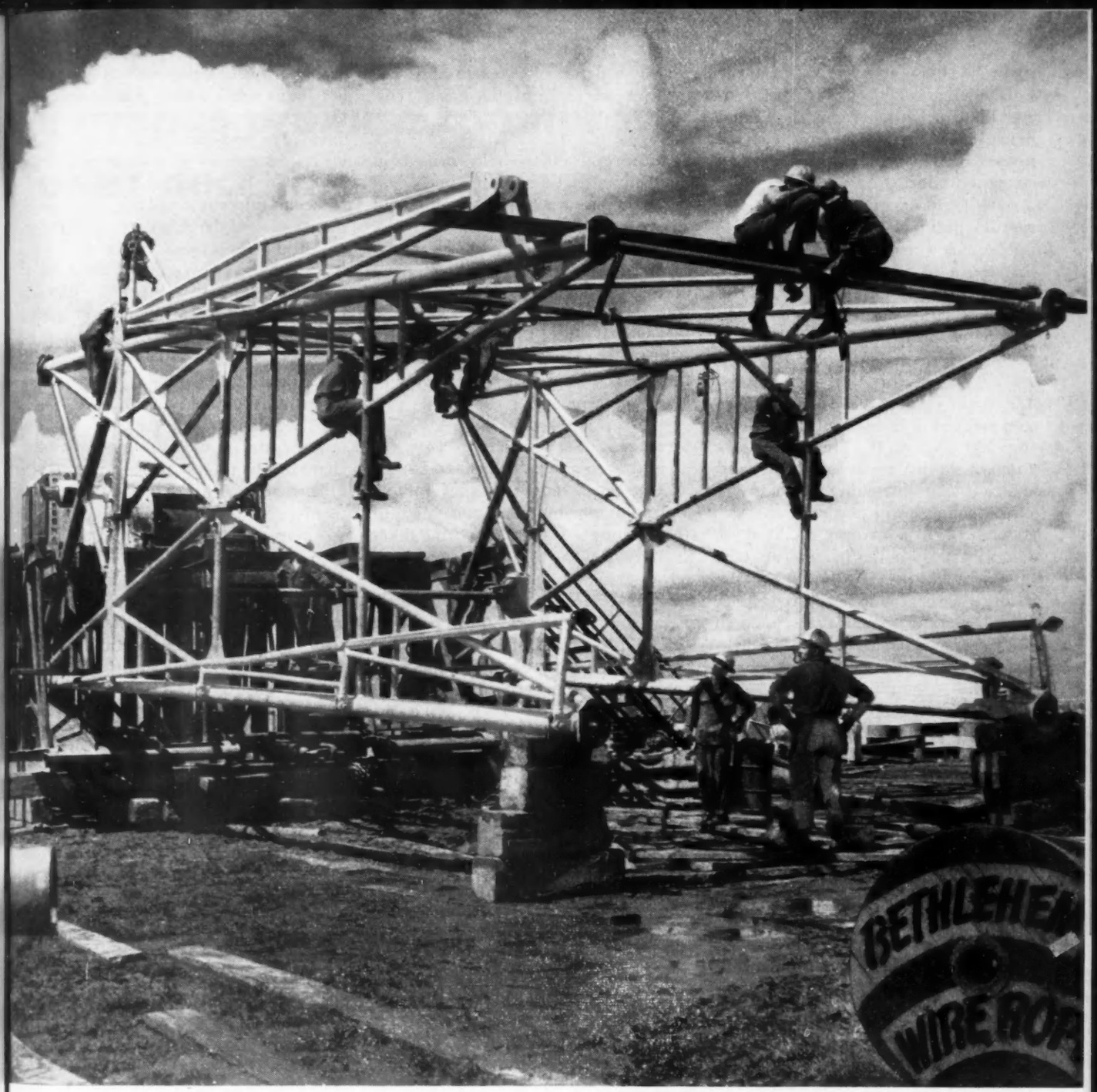
There is much to be learned about the geology of Haiti, for all of the work done to date has been of a reconnaissance nature. Woodring and others conducted a survey of the Republic in 1921-1922, and this work forms an excellent foundation from which to start. More recently, Jacques Butterlin, the French geologist, published a review of the geology of Haiti in 1954. In 1956, the same author published his "La Constitution Geologique et la Structure des Antilles." The writer has drawn freely from these works and from various private reports.

**Stratigraphy.** Sedimentary rocks are exposed at the surface over fully four-fifths of the republic. Their age ranges from probable Paleozoic to Recent. The oldest rocks of sedimentary origin in Haiti are Paleozoic (?) metamorphosed shales, sandstones, limestones and conglomerates. This series is schistose, and age determination is uncertain. These rocks are exposed in some of the mountain ranges of Haiti, and generally lie on either side of a central intrusive belt. (Jones, Page 731.) Structurally, these rocks are extremely complex, and in most exposures the structure is undecipherable. These metamorphics have been invaded by intrusives and extrusives of probable Mesozoic age, and together they form the basement series on the Ile d'Haiti.

Prior to Cretaceous time, there was general emergence in Haiti, and the old Paleozoic (?) deposits were deeply eroded. In general, the lower and middle Cretaceous deposits are principally clastic in origin, with some marine argillaceous limestones of unknown but impressive thicknesses. Late in the Cretaceous, the Antillean region was subjected to a period of violent igneous activity and mountain building, and the Ile d'Haiti did not escape this orogeny. Cretaceous rocks were intensely folded and metamorphosed to various degrees of severity. Structural deformation in the mountain ranges is so complex that it is impossible to work out local structure, and these areas are delineated simply as pre-Tertiary complexes.

A widespread angular unconformity separates the Mesozoic from the Tertiary. Woodring does not recognize the presence of Paleocene or Lower Eocene rocks in Haiti. But Butterlin identifies deposits which he assigns to the Paleocene in the south, central and northern parts of the republic. He also reports Lower Eocene massive limestones, which in places are chalky or flinty. Whatever their differences of opinion may be as to the age of the basal beds immediately overlying the Cretaceous, both writers are in general agreement as to the subdivision of the great bulk of the Tertiary rocks of Haiti. The present writer feels that it is this latter section that offers the greatest possibilities as source and reservoir beds for petroleum.

Using Butterlin's estimated thicknesses, some 26,000 feet of largely marine Tertiary limestones, marls, shales and sandstones were originally deposited unconformably on the Cretaceous. The Eocene beds are predominately limestones, as are the Oligocene. However, throughout the Oligocene the sediments become more and more clastic, until by Miocene times deposition was principally conglomerates, sand, shales and thin bedden limestones. In general, the Miocene sediments are considerably




**Moving day for the workover outfit.** Moving a workover rig is a task requiring skill, coordination, teamwork. But the crew can take it in stride, for a portable outfit is mobile as a circus and is handled in the same efficient way. This picture shows a rig being moved off a typical flowing well in southern Louisiana.

The workover specialists had just finished servicing the well, which was over 10,000 ft deep. The job of pulling and rerunning tubing was done with the rotary line, a Bethlehem Purple Strand rope with IWRC. Purple Strand was also the choice of the trucking firm engaged to load and move the rig. In both cases, the ropes were Form-Set (preformed) to insure good spooling and resistance to kinking.

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more carbonaceous than are the Eocene-Oligocene beds. In the Central Plateau carbonaceous shales and marls of Miocene age are reported in wells and from outcrops with strong oil odor, stain and ether cut.

Middle Miocene beds in the Enriquillo Basin of the Dominican Republic, an extension of the Cul de Sac Basin of Haiti, are reported to have oil odors at numerous exposures. In that same basin, Seaboard Oil Company drilled their Mella 1 in 1946 to a total depth of 8,769 feet. At 7,050 feet this well encountered 1,200 feet of anhydrite and gypsum, and stopped in bedded salt after drilling 500 feet of it. These beds are thought to be lower Miocene, and indicate that Enriquillo Basin was a closed saline basin at that time.

Although none are reported in Haiti, black shales of Lower Oligocene (?) age are found in the Dominican Republic in the Azua Basin, which is genetically related to the Central Plateau Basin of Haiti. In the Azua Basin of the Dominican Republic, several wells were drilled around an oil seep on the Higuerita Dome in 1905, and a small amount of production was obtained from Miocene rocks. Rumors as to the amount of oil produced vary from a few hundred to 18,000 barrels.

However, this much is certain:

**1.** Oil was accumulated in Miocene rocks with sufficient permeability and in sufficient volume to blow out a well at a depth of 905 feet and flow for two weeks until the casing collapsed.

**2.** Several other wells drilled in the vicinity encountered numerous oil shows, some of which gave up small amounts of oil on test.

**3.** In 1939 Seaboard Oil Company produced about 40,000 barrels of oil from a well on the Maleno dome in the Azua Basin of the Dominican Republic. Pena reports that this production was from lenticular sands of lower Miocene age.

**Structure.** Structurally, the Ile d'Haiti is complex. The island is part of the West Indian belt of folding and mountain building, and much of the orogeny is young. Woodring notes that there were three principal periods of folding, one at the end of Cretaceous time, one at the end of Eocene time, and one during and at the end of the Miocene. Probably each of the periods of folding continued into the succeeding geologic period. In parts of the republic, the folding that began in Miocene time still continues.

This succession of emergence and submergence had a marked effect on the stratigraphy of the island. Close study will undoubtedly reveal a correlation between the lithology and structural deformation. This deformation has produced mountain blocks of high relief, separated by low relief basin areas which were negative throughout much of post-Miocene time. The synclinal basins received great thicknesses of Oligocene-Miocene-Pliocene detritals. Subsequent Miocene-Pliocene folding has produced several large closed anticlines within the basin areas.

Field evidence indicates that the Central Plateau, Artibonite Valley and the Cul de Sac Valley are deep synclinal troughs (Figure 2), bounded by broad anticlinal mountain ranges. The positions of these troughs or basins were probably established during the period of late Eocene folding and possibly even earlier. At any rate, they received great thicknesses of Oligocene and Miocene marine sediments.

The present morphology and structure was formed by the folding and crumpling of the rocks during Miocene and Pliocene times. The present mountain blocks were uplifted as massive, complexly faulted anticlines, accentuating the down-warped basin areas, which received sediments poured into them by erosion of the mountain blocks. The Northwest Peninsula, Montagnes Noires, Chaine des Mateaux and the Ile d'Gonave are examples of anticlinal mountain blocks.

Because of structural complexity and lack of suitable reservoir rocks, the value of these massive uplifts as

*Continued on Page 152*

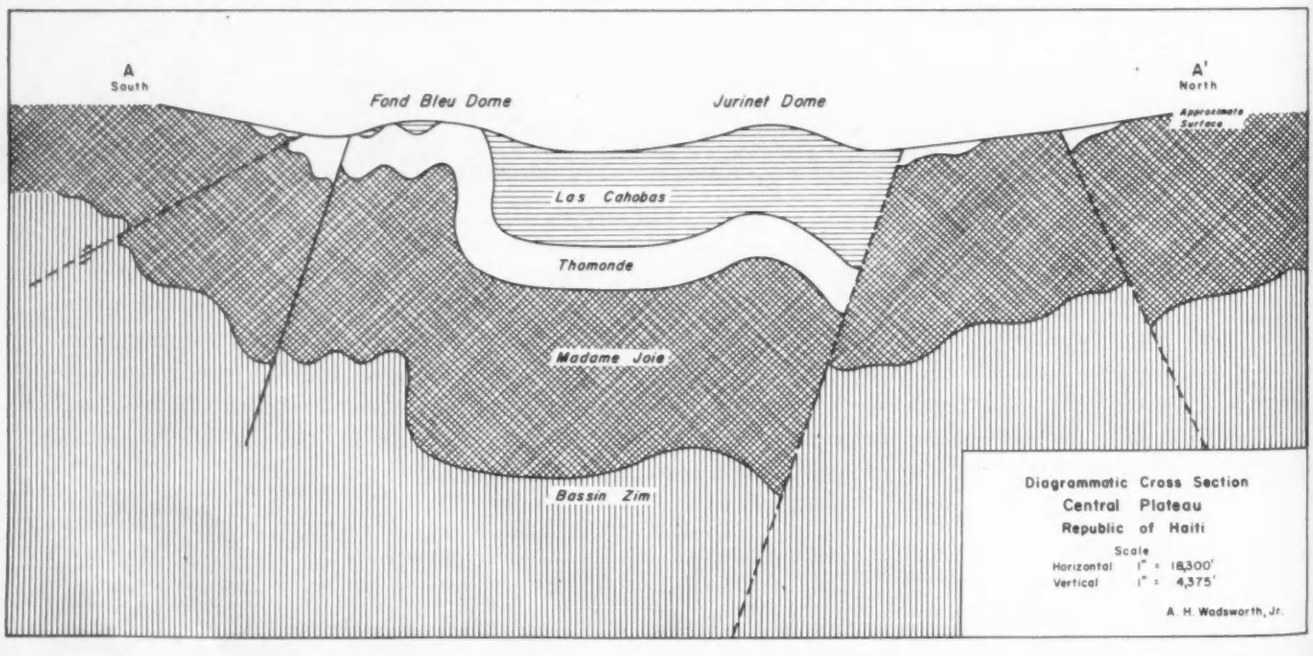


**FIGURE 3—Diagrammatic cross-section, showing formations in the Central Plateau Basin of Haiti. The section is located along the line A—A', as shown on the map in Figure 1, to the right of the center of the map.**

# Earnings promise to improve after declining for a year

## Oil industry profits were off 38 percent in second quarter, following 33 percent drop in first quarter.

**By L. J. Logan,** WORLD OIL Staff

THE TREND of oil company earnings continues about the same as that of business in general. The trends currently are improving for both the petroleum industry and for business as a whole. They were very unfavorable in the first and second quarters of this year, after having turned unfavorable in the third and fourth quarters of last year.

Earnings in oil, as in other lines in the aggregate, probably will be less than a year ago during the third quarter of 1958. But the decreases should be considerably smaller than those of the first and second quarters.

The improving economic situation will aid the oil industry along with other lines of business. Demand for oil is improving as the business recovery develops. In the third quarter, it may equal the year ago trend. The demand had been off sharply in the first quarter and the beginning of the second quarter. But thereafter the decreases became smaller.

In the first and second quarters of this year, oil company profits were sharply curtailed by the shrinkage of oil demand, drastic curtailment of crude oil production and refinery runs, and serious weakening of prices of gasoline and other refined products.

Currently, however, industry operations are being stepped up, in response to better demand. Crude oil production is being gradually increased from the bottoms reached in April, May, and June. Refinery runs are being expanded proportionally. Prices of refined products have been improving since the middle of the year. Both producers and refiners will benefit from these trends.

However, production volumes and product prices still are lower than a year ago. The industry also has had further increases in costs of steel products and other items. Consequently, it is unlikely that oil company earnings in the third quarter of this year can equal those of the like period last year.

Oil industry earnings in the second quarter of 1958 were about 38 percent lower than in the like period of 1957. This is indicated by the WORLD OIL table herewith. Forty-one oil companies earned $471,322,000 in this year's second quarter, compared with $758,872,000 in last year's, a decrease of 37.9 percent.

In the first quarter of this year, the industry's earnings were off 33 percent from a year earlier (WORLD OIL, June 1958, Page 93). The earnings had been down about 13 percent in the fourth quarter of 1957 and off about 7 percent in the third quarter of 1957.

**—The End**

### Net Earnings of Some Oil Companies in Second Quarter and First Half, 1958 vs. 1957

(All "per share" data based on number of shares of common stock outstanding June 30, 1958)

| COMPANY | SECOND QUARTER $ Thousand 1958 | SECOND QUARTER $ Thousand 1957 | SECOND QUARTER $ Per Share 1958 | SECOND QUARTER $ Per Share 1957 | SECOND QUARTER % Dif. | FIRST HALF $ Thousand 1958 | FIRST HALF $ Thousand 1957 | FIRST HALF $Per Share 1958 | FIRST HALF $Per Share 1957 | FIRST HALF % Dif. |
|---|---|---|---|---|---|---|---|---|---|---|
| Amerada Pet. | 4,299 | 6,901 | .68 | 1.09 | —38 | 9,850 | 15,647 | 1.56 | 2.48 | —37 |
| Anderson-Prich. | 718 | 1,336 | .37 | .75 | —46 | 1,377 | 2,820 | .71 | 1.59 | —51 |
| Ark. Fuel Oil | 1,018 | 1,689 | .27 | .44 | —40 | 3,323 | 3,925 | .87 | 1.03 | —15 |
| Ashland O. & R. | 1,315 | 3,656 | .16 | .64 | —64 | 3,780 | 8,575 | .66 | 1.50 | —56 |
| Atlantic Ref. Co. | 4,972 | 10,573 | .52 | 1.13 | —53 | 7,667 | 25,332 | .78 | 2.74 | —70 |
| Champlin O. & R. | 1,563 | 2,175 | .36 | .54 | —28 | 2,865 | 5,342 | .66 | 1.29 | —46 |
| Cities Service Co. | 11,114 | 12,889 | 1.06 | 1.23 | —14 | 24,618 | 36,315 | 2.34 | 3.45 | —32 |
| Clark O. & R. | 63 | 220 | .05 | .16 | —71 | 222 | 692 | .16 | .50 | —68 |
| Colorado O. & G. | 265 | 764 | .04 | .21 | —65 | 595 | 1,454 | .10 | .39 | —59 |
| Continental Oil | 9,509 | 10,074 | .48 | .51 | — 6 | 20,208 | 23,714 | 1.03 | 1.21 | —15 |
| *Creole Pet. Corp. | 74,692 | 113,341 | .96 | 1.46 | —34 | 160,913 | 221,648 | 2.07 | 2.86 | —27 |
| Felmont Pet. Corp. | 227 | 808 | .06 | .22 | —72 | 942 | 1,668 | .25 | .45 | —43 |
| Getty Oil Co. | 911 | 3,656 | .05 | .22 | —75 | 7,980 | 12,962 | .48 | .80 | —38 |
| Gulf Oil Corp. | 55,069 | 106,817 | 1.77 | 3.43 | —48 | 115,737 | 201,755 | 3.72 | 6.48 | —43 |
| Hancock Oil Co. | 1,526 | 1,874 | .38 | .47 | —19 | 3,310 | 3,835 | .87 | 1.01 | —14 |
| Honolulu Oil | 2,187 | 3,773 | .58 | 1.01 | —42 | 5,586 | 7,616 | 1.49 | 2.03 | —27 |
| *Humble O. & R. | | | | | | 57,182 | 116,136 | .79 | 1.62 | —51 |
| *Imperial Oil | 9,131 | 16,081 | .29 | .52 | —43 | 24,153 | 37,662 | .77 | 1.20 | —36 |
| *International Pet. | | | | | | 12,900 | 23,300 | .89 | 1.60 | —45 |
| La. Land & Expl. | 4,061 | 5,031 | .46 | .56 | —19 | 8,861 | 10,503 | .99 | 1.17 | —16 |
| Maracaibo Oil | 48 | 130 | .10 | .26 | —63 | 139 | 294 | .28 | .60 | —53 |
| Ohio Oil Co. | 6,719 | 9,567 | .51 | .73 | —30 | 15,087 | 22,233 | 1.15 | 1.69 | —32 |
| Phillips Pet. Co. | 15,895 | 25,019 | .46 | .72 | —36 | 36,412 | 53,399 | 1.06 | 1.55 | —32 |
| Plymouth Oil Co. | 650 | 1,886 | .26 | .75 | —65 | 1,520 | 4,405 | .61 | 1.76 | —65 |
| Pure Oil Co. | 5,943 | 8,842 | .69 | 1.03 | —33 | 10,675 | 19,012 | 1.24 | 2.21 | —44 |
| Quaker State | 522 | 588 | .63 | .71 | —11 | 811 | 958 | .98 | 1.16 | —15 |
| Richfield Oil | 4,804 | 6,666 | 1.20 | 1.67 | —28 | 10,410 | 13,705 | 2.60 | 3.43 | —24 |
| Shell Oil Co. | 19,182 | 33,871 | .63 | 1.12 | —43 | 45,752 | 106,321 | 1.51 | 2.49 | —57 |
| Signal O. & G. | 2,760 | 2,960 | .63 | .68 | — 7 | 5,660 | 6,136 | 1.29 | 1.40 | — 8 |
| Sinclair Oil | 8,399 | 18,546 | .55 | 1.21 | —55 | 24,807 | 44,848 | 1.62 | 2.93 | —45 |
| Skelly Oil | 4,535 | 8,545 | .78 | 1.48 | —47 | 10,549 | 19,934 | 1.83 | 3.46 | —47 |
| Socony Mobil | 28,400 | 59,100 | .59 | 1.22 | —52 | 67,500 | 126,800 | 1.40 | 2.62 | —47 |
| Standard, Calif. | 59,325 | 63,224 | .94 | 1.06 | — 6 | 116,735 | 136,329 | 1.85 | 2.16 | —14 |
| Standard, Ky. | 3,061 | 3,049 | 1.18 | 1.17 | + 1 | 6,301 | 6,332 | 2.42 | 2.43 | — 1 |
| Standard, N.J. | 124,000 | 226,000 | .82 | 1.11 | —45 | 291,000 | 463,000 | 1.43 | 2.27 | —37 |
| Standard, Ohio | 4,036 | 4,782 | .80 | .94 | —16 | †8,355 | 12,623 | †1.65 | 2.53 | —34 |
| Sun Oil Co. | 7,985 | 11,856 | .70 | 1.04 | —33 | 11,560 | 25,187 | 1.01 | 2.34 | —54 |
| Texas Company | 68,532 | 78,722 | 1.17 | 1.44 | —13 | 138,536 | 165,146 | 2.37 | 3.01 | —16 |
| Texas Gulf Prod. | 452 | 1,786 | .11 | .44 | —75 | 1,617 | 3,666 | .40 | .91 | —56 |
| Texas Pac. C & O. | 857 | 1,881 | .24 | .52 | —54 | 2,353 | 3,949 | .65 | 1.10 | —40 |
| Tidewater Oil Co. | d524 | 10,090 | | .67 | | 279 | 21,569 | | 1.52 | —99 |
| Union Oil, Calif. | 5,462 | 7,400 | .70 | .94 | —26 | 11,457 | 16,727 | 1.46 | 2.13 | —31 |
| Universal Consol. | 641 | 946 | .67 | .99 | —32 | 1,123 | 1,927 | 1.17 | 2.01 | —42 |
| Wilcox Oil Co. | 180 | 281 | .58 | .93 | —36 | 369 | 535 | 1.22 | 1.81 | —31 |
| Woodley Pet. Co. | 641 | 899 | .78 | 1.10 | —29 | 1,281 | 1,749 | 1.56 | 2.13 | —27 |
| *Total, 41 Companies | 471,322 | 758,872 | | | —38 | 1,037,209 | 1,638,929 | | | —37 |

* Creole, Humble, Imperial, and International Pet. are excluded from totals, being included as affiliates of Standard (N.J.).
† Excludes reported non-receiving profit from sale of properties.
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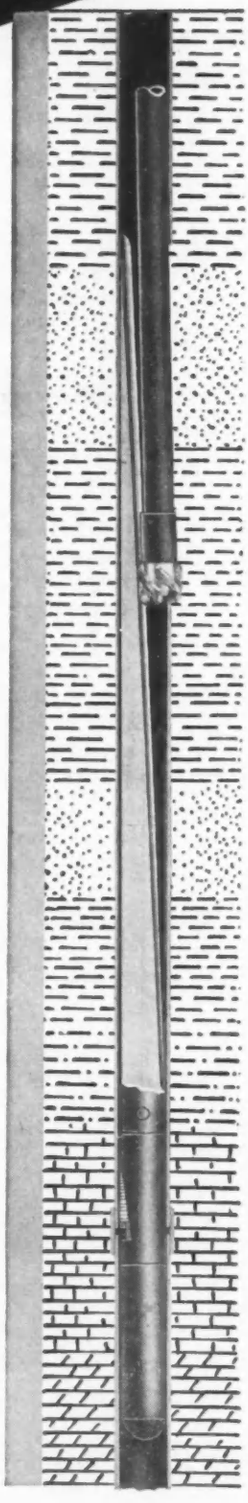

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## Haiti Possibilities

*Continued from Page 146*

petroleum prospects is questionable. On the other hand, almost ideal conditions exist in the basin areas for petroleum accumulation. Basinal deposition that was contemporaneous with structural deformation has resulted in the formation of many oil and gas traps the world over. It is considered likely that Haiti will be no exception.

**Sedimentary basins.** The best possibilities for oil and gas deposits in Haiti are in the four sedimentary basins. Although no wells have been drilled in the anticlinal mountain blocks, the writer believes that complex structural conditions and unfavorable stratigraphy make them less attractive.

**1. Central Plateau Basin.** This basin is a continuation of the San Juan Basin of the Dominican Republic. In both countries it is about 135 miles long and approximately 15 miles wide. The Haitian part of the basin is about 50 miles long. The basin has been a negative area since Eocene times. It has received great thicknesses of marine Oligocene and Miocene sands, shales and limestones. Most Pliocene, Pleistocene and Recent deposits are non-marine. They consist of conglomerates and alluvial deposits from the bordering mountain ranges. The Central Plateau Basin contains at least 20,000 feet of Tertiary sediments, nearly all of which are marine in origin.

Structurally, the basin is a typical intermontane synclinal basin. The northwest end was closed by post-Eocene mountain building. But the southeast (Dominican Republic) part remained open throughout Oligocene, Miocene and part of Pliocene time.

The flanks of the basin are defined in some areas by overturned folds and thrust faults, with the hanging wall moving from the mountains out into the basin. This has tended to narrow the structural width of the basin. Consequently basin sediments have been folded by compression into anticlines and synclines around the basin edge. Photogeology has disclosed several closed anticlines at the surface. Reconnaissance geophysical work indicates the presence of buried structures.

Oil and gas seeps and a small

amount of oil production have already been described from the Azua Basin in the Dominican Republic, which is structurally related to the Central Plateau-San Juan Basin.

**2. Cul de Sac Basin.** The Cul de Sac is a remarkable surface feature. It is a deep structural and topographic trough, flanked by high mountains that extend from sea level to more than 8,000 feet. The floor of the basin is flat, and averages about 150 feet in elevation. In the Dominican Republic this basin is called Enriquillo.

Woodring states that the Cul de Sac is clearly a syncline. Miocene beds are upturned on the flanks of the mountains bordering it, and similar beds have been penetrated by water wells in the plain. As in the Central Plateau, the trough is bounded by zones of high angle thrust faults that dip toward the mountains. Although the floor of the Cul de Sac is covered by alluvium, these structural conditions suggest that the basin rocks should be folded, as are those in the Central Plateau, where the same conditions exist. Because of poor exposures, little is known of the stratigraphy.

In 1947 The Atlantic Refining Company drilled its Cul de Sac 1 to a depth of 8,064 feet. The well started in post-Miocene beds and bottomed in the Bassin Zim formation. The upper 2,500 feet was predominately shale, sandstone and marl. The lower section was principally limestone. Oil shows were reported at 6,500 feet and 7,500 feet in limestone. Pena reports numerous oil and gas seeps in the Cul de Sac Basin south of the Dominican village of Boca de Cachon.

**3. Artibonite Basin.** The Artibonite Valley resembles the Central Plain in many ways. It is structurally a northwest plunging syncline, modified by secondary anticlinal and synclinal folds. It is floored by rocks of the same age. But because of poor exposures, little is known of their lithology.

The Atlantic Refining Company drilled its St. Marc well north of the coastal town of that name in 1947. This well started in Thomonde beds and was in the Madame Joie formation from 3,000 feet to total depth of 4,099 feet. Both formations were composed of gray calcareous shale, with a few stringers of limestone and sandstone. No shows of oil or gas were reported.

Several closed anticlines occur along the flanks of the basin. In all probability, buried structures lie concealed beneath the valley fill.

**4. Cayes Basin.** This small basin is on the southern peninsula. Very little is known of its geology. Woodring describes it as a small syncline, plunging southward into the Caribbean, containing Miocene or older rocks. Where these beds are observed at the surface, they do not appear to be folded. It has been rumored that a water well near the village of Cayes found a small amount of oil. But this is unconfirmed.

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**About the Author**

**A. H. Wadsworth, Jr.,** is a consulting geologist. He received a B.S. and M.A. in geology from The University of Texas in 1941 and has worked for Seaboard Oil Company, The Texas Company and the United States Geological Survey. A consultant in Bay City, Texas, since 1950, he moved his offices to Houston in 1957. During 1956 and 1957 he served as consultant to Commonwealth Oil Company in charge of that company's exploration program in Haiti.



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| 1–13 | International Conference on the Peaceful Uses of Atomic Energy, Geneva, Switzerland. |
| 7–11 | World Power Conference, Montreal, Quebec, Queen Elizabeth Hotel. |
| 10–12 | National Petroleum Association, 56th Annual Meeting, Atlantic City, N. J., Traymore Hotel. |
| 15–19 | Instrument Society of America, 13th Annual Instrument-Automation Conference and Exhibit, Philadelphia, Penn. |
| 18–20 | Rocky Mountain Association of Geologists, Annual Field Trip, Northwestern Colorado, Glenwood Springs, Colorado. |
| 21–24 | AIME, Conference on Petroleum, Denver, Cosmopolitan Hotel. |
| 25–26 | Mid-Continent Oil & Gas Assn., La.-Ark. Division, Annual Meeting, New Orleans, Roosevelt Hotel. |
| 25–27 | Illinois State Geological Survey, Biennial Petroleum Engineering Conference, the University of Illinois Campus. |
| **OCT.** | |
| 1– 3 | AAODC, 18th Annual Meeting, Dallas, Adolphus and Baker Hotels. |
| 5– 8 | AIME, Society of Petroleum Engineers, Fall Meeting, Houston |
| 7– 8 | Texas Mid-Continent Oil & Gas Assn., 39th Annual Meeting, Dallas, Statler-Hilton Hotel. |
| 9–12 | Tri-State Oil Show, The Roberts Municipal Stadium, Evansville, Ind. |
| 10–11 | Desk and Derrick Club, 7th Annual Convention, Los Angeles, Biltmore Hotel. |
| 12–18 | OIL Progress Week. |
| 13–15 | AGA Annual Convention, Atlantic City, Site Unreported. |
| 13–16 | Society of Exploration Geophysicists, 28th Annual International Meeting, San Antonio, Gunter Hotel. |
| 15–16 | South Dakota Independent Oil Men's Assn., Convention, Rapid City, S. D., Sheraton-Johnson Hotel. |
| 15–17 | Second Energy Resources Conference, Denver, Brown Palace Hotel. |
| 16–17 | AIME, Southern California Petroleum Section Fall Meeting, Los Angeles, Biltmore Hotel. |
| 16–19 | 1958 Permian Basin Oil Show, Odessa, Texas. |
| 20–24 | National Safety Council, Annual Convention, Chicago, Conrad Hilton Hotel. |
| 23–24 | Rocky Mountain Oil and Gas Association, Annual Fall Meeting, Town House Motel, Omaha, Neb. |
| 23–25 | AIME, Mid-American Minerals Conference, Chase, Plaza Hotels, St. Louis. |
| 27–28 | IPAA Annual Meeting, Dallas, Statler-Hilton. |
| 27–29 | Gulf Coast Association of Geological Societies, Convention, Corpus Christi, Texas. |
| **NOV.** | |
| 6– 7 | AAPG Pacific section, Annual Meeting, Los Angeles. |
| 10–13 | API 38th Annual Meeting, Chicago, Conrad Hilton, Palmer House and Congress Hotels. |
| 21–22 | "Legal Problems in the Tidelands" Study Program, Tulane University, New Orleans. |
| **DEC.** | |
| 5 | ASME, Annual Meeting, New York City, Statler & Sheraton-McAlpin Hotels. |

Nomads' Chapter monthly meeting: Los Angeles, second Wednesday, Jonathan Club, Wallace A. Sawdon, Secretary. Houston, second Monday, Ye Old College Inn, Harry E. Estes, Secretary. Dallas-Fort Worth, first Monday, Greater Dallas Club, Hank Davis, Secretary. Tulsa, Hotel Tulsa, Gilbert Swift, Secretary. New York, first Monday, Hotel Biltmore, Jesse E. Hickman, Secretary.

## What's Happening among MEN in the INDUSTRY

A. L. Solliday

F. R. Yost

E. F. Bullard

**E. F. Bullard** has been elected chairman of the board, and **A. L. Solliday president** of **Pan American Corp.** In another executive change, **F. R. Yost** was elected executive vice president. Bullard becomes Pan American's second chairman. The post was held by **F. O. Prior** for a time in 1945 but has been vacant since.

**John M. Stevenson,** formerly senior mechanical engineer for **Delhi-Taylor Oil Corporation,** has formed his own independent engineering service.

**Wilbur A. Yeager, Jr.,** has been appointed petroleum engineer in the Oil Loan department of The First National Bank in Midland, Texas.

**Jack H. Abernathy,** former president of the American Association of Oilwell Drilling Co., has been named president of **Big Chief Drilling Co.,** succeeding **William T. (Bill) Payne,** founder of the company, who becomes chairman of the board. **Sidney V. Hodges** was named president of the **Columbia Oil Co.,** an oil-producing affiliate of Big Chief, and was also promoted to senior vice president in charge of drilling for Big Chief. **F. E. Godfrey,** treasurer, was named a director, and **Ted C. Findeiss,** attorney, was made secretary.

**Robert C. Sharp,** was selected to take full charge of all overseas operations for the **International Brown Drilling Co.** Sharp, who will also hold a vice president's title, served in a vice presidential capacity with the Drilling & Exploration Co. of Delaware, Inc., for 13 years before taking his new post with Brown.

**Thomas L. Wark,** vice president, has been appointed special assistant to the president of **Tidewater Oil Company.** Wark was formerly Western division general manager, with headquarters in San Francisco. Vice President **Charles R. Brown** has been named Western division general manager, succeeding Wark. Brown's prior post was Central division general manager in Tulsa. **Lloyd Armstrong,** previously Southern division assistant general manager, with Houston headquarters, has been appointed Central division general manager, succeeding Brown.

**Frank M. Jacobson,** vice president of Murphy-Canada Oil Co., has been elected president and a director of **Amurex Oil Company,** and **Paul C. McDonald,** vice president of Murphy Corporation, has been elected an Amurex director. They succeed **W. L. Falconer,** former president and director and **Oliver H. Payne,** former director, who have resigned.

**G. T. Pearson** has been appointed chairman of the Texas oil industry's public relations program for the next two years. Pearson's appointment as Texas Oil Information Committee chairman was announced by Southwest OIC Chairman J. L. Sewell. Pearson is regional general manager of Continental Oil Company.

**Harold D. Osborn** has been elected a director and treasurer of **General Petroleum Corporation.** Osborn also became comptroller of the company.

E. L. Gorham, Jr.

**Edwin L. Gorham, Jr.,** has been appointed general manager of **The Texas Company's** Foreign Producing department (Western Hemisphere and West Africa). Gorham, formerly manager of the department, succeeds **A. W. Baucum.**

**Albert B. Stevens,** formerly general manager of **Farnsworth & Chambers Oil** Company has purchased the company's producing properties in West Texas. He has established the firm of Albert B. Stevens & Associates, with offices in Houston, to operate these properties and to engage in oil and gas property evaluation and management.

**Edward E. Adams** has been appointed manager, Personnel and Labor Relations, Producing department, **Standard Oil Company of California, Western Operations, Inc.** Adams, who has been with Standard's Producing department since 1938, moves up from the position of superintendent, Kerto-Cymric district near Taft, Calif. He succeeds **Edwin J. Ball,** who retired recently after more than 38 years service with the company.

**Dr. George H. Fancher,** The University of Texas petroleum engineering department chairman, has been invited by the Colom-

bian government to help organize a department of conservation within the Colombian ministry of mines and petroleum.

**Arthur Eric C. Drake** was appointed to the board of directors of **The British Petroleum Company Ltd.** He succeeds **Robert Gillespie** who plans to retire June 30. Drake is a director of BP Trading Ltd., the company's principal trading subsidiary. From 1952 to 1954, he served as the company's representative in the United States.

A. E. C. Drake

**Standard-Vacuum Oil Company** has named five regional vice presidents to coordinate its operations in the Eastern Hemisphere. Serving in a new executive category, the regional vice presidents will have over-all responsibility at Stanvac's White Plains, N. Y., headquarters for the company's interests in their respective overseas regions. The new appointees and the areas for which they will be responsible are **James V. Pickering,** Stanvac's Far East region including Japan, Korea, Colony of Hong Kong, Philippines, Viet Nam, Cambodia, Laos, Thailand, Malaya and the Colony of Singapore; **Stanley W. G. Lehman,** South Asia region including India, Pakistan, Burma and Ceylon. **Gerard L. McCoy,** Indonesia region; **Rufus T. Burton,** Australia-New Zealand region including Papua, Australian New Guinea and the South Pacific Islands; and **Charles E. Solomon,** Africa region, including southern Africa, East Africa and the Red Sea area.

**International Petroleum Company, Limited** announced the appointment of **Henry E. Winter** as executive representative in Venezuela. Winter will succeed **Edmund C. Breene, Jr.,** who is retiring after 24 years service with International and other affiliates of Standard Oil Company (New Jersey).

**Henry Callaway** recently became a partner in the consulting firm of **Leibrock, Landreth & Campbell.**

**C. L. Franke** has been employed by **Plymouth Oil Company** as regional production superintendent in the company's office at Calgary, Alberta, Canada.

**Sohio Petroleum Company** has announced the transfer of **Walt Granata** to the Lafayette, La., office. Granata is a geologist and has been with Sohio since 1952. He is transferring from the division office in Houston.

**Dr. James A. Tong,** president of **Socony Mobil Oil Company de Venezuela,** received the 1958 Alumni Achievement Award from the University of Arizona. He is a member of the University's class of 1918.

**Monroe E. Spaght,** executive vice president of **Shell Oil Company,** was awarded an honorary Doctor of Science degree by Rensselaer Polytechnic Institute.

**Gordon W. Duncan,** assistant director, Technical Information division, Esso Research and Engineering Company, has accepted an appointment for one year as assistant general secretary of the Fifth World Petroleum Congress.

**Robert H. Ray Co.** has announced the appointment of **Jesse O. Sims** as seismic supervisor of its newly opened Four Corners area district office in Durango, Colo.

**C. J. Christensen** has been named division production superintendent for **Pan American Petroleum Corp.'s** Canadian division, with headquarters in Calgary.

**Frank L. Dennis** has resigned as director of Press and Publication service of the U. S. Information Service, to accept a position as a special assistant to **Frank M. Porter,** president, American Petroleum Institute.

**T. C. Bodley,** president of Mohawk Petroleum Co., has been elected a director of the Petroleum Club of Tulsa, succeeding the late Andrew M. Rowley.

**The Vickers Petroleum Co., Inc.,** announced that **James W. Vickers** had been elected to the firm's board of directors. Vice president of marketing for the company, Vickers is president of the Kent Oil Company.

**D. H. Barran** has been elected president of **Asiatic Petroleum Corporation** and **Shell Caribbean Petroleum Company.** He joined the Royal Dutch Shell Group of Companies in 1934 in London and has served in Egypt, the Sudan, Ethiopia, Israel and India. He returned to London in 1947 and worked in Supplies Administration department of The Shell Petroleum Company, Limited, London. In 1957 he was appointed Head of Supplies Administration and a member of the Co-ordinating Committee.

D. H. Barran

**Standard Oil Company (New Jersey)** announced the appointment of **Dr. Siro Vázquez** of Caracas, Venezuela, to be Coordinator of its Producing Coordination department, responsible for coordinating the production activities of its affiliates throughout the world. Dr. Vázquez, who has been a director of Creole Petroleum Corporation, was named to succeed **M. A. Wright,** who was elected to the board of directors of Jersey Standard recently.

**Lone Star Producing Company,** wholly-owned subsidiary of Lone Star Gas Company, elected three new directors. They are **Louis G. James, Willard G. Wiegel** and **Carl M. Hill.** Each is an officer in the parent gas company and of Lone Star Producing Company. James is executive vice president (finance and accounting), Wiegel is vice president (personnel) and treasurer, and Hill is vice president (exploration and gas supply.

**Floyd Brett** has succeeded **W. R. (Dick) Thixton** as vice president and manager of **Sinclair Oil and Gas Co.'s** Tulsa division. Thixton retired June 1 after serving with the company since 1934. He went to Tulsa in 1941, became division manager in 1952 and vice president and manager of the Tulsa division in 1954.

H. A. Trueblood

S. A. Levine

**Consolidated Oil & Gas, Inc.,** announced its principal managing officers and new directorate. **Harry A. Trueblood, Jr.,** has been elected president and chairman of the board. He was formerly president of Colorado Western Exploration, Inc. **Saul A. Levine** has been elected secretary-treasurer. He formerly served in the same capacity for both Colorado Western Exploration, Inc., and Consolidated Rimrock Oil Corporation which companies recently merged to form Consolidated Oil & Gas. Also serving on the board of directors are **Henry A. Wilmerding, Harley B. Graff, John E. Price, H. Harold Calkins** and **Theodor F. Rittenberg.**

**John W. Proctor,** general manager of the **Canadian Petroleum Association** announced the appointment of **William D. Stuart** as executive assistant to the general manager of the association.

**A. Carl Tutschulte** has been promoted to divisional petroleum engineer of **Tidewater Oil Company's** Western division. He will be responsible for petroleum engineering in the company's Seven State and Hawaii Western division and replaces **Roy S. Curl,** who retired recently after 36 years of service with the company.

**Robert Di Giorgio,** vice president of the Di Giorgio Fruit Corporation, has been elected a director of **Union Oil Company of California.**

**Southern California Petroleum Corporation** announced the election of **Herman J. Stern** to its board of directors. Stern is a partner of Stern, Frank, Meyer & Fox, members of the New York Stock Exchange.

**General Petroleum Corporation** made some changes in its Production department. **A. McLean,** coastal division superintendent with headquarters at Ventura, Calif., and a General Petroleum employe for 44 years, retired August 1. He will be succeeded by **Donald B. Priest,** presently a special assistant in the Los Angeles home office and formerly assistant to McLean for eight years. Priest will be succeeded by **J. J. Browne,** former assistant to the superintendent, San Joaquin division, with headquarters at Taft. **Donald F. J. McIntosh,** former assistant to McLean at Ventura, will succeed Browne.

**J. C. Donnell, II,** president of The Ohio Oil Company, has accepted the chairmanship of the Petroleum and Natural Gas

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C. A. White ..... EM 5-3833
HOBBS, NEW MEXICO
Horne Well Service Co. ..... 3-5396
HOUSTON, TEXAS
Assoc. Eng. & Eqpt., Inc. ..... CA 5-1103
KILGORE, TEXAS
Davis-Kemp Tool Co., Inc. ..... 8541
LAFAYETTE, LOUISIANA
Assoc. Eng. & Eqpt., Inc. ..... CE 5-6770
LIBERAL, KANSAS
Rainbo Service ..... Main 4-3598
LINDSAY, OKLAHOMA
Rainbo Service Co. ..... 530
MIDLAND, TEXAS
Luceous Service & Eqpt. Co. ..... MU 2-1631
NEW ORLEANS, LOUISIANA
Assoc. Eng. & Eqpt., Inc. ..... VE 5-4983
OKLAHOMA CITY, OKLAHOMA
Rainbo Service Co. ..... ME 4-2131, ME 4-0105
WHITTIER, CALIFORNIA
Kline Wire Line Co. ..... OX 3-2731
WICHITA FALLS, TEXAS
Hudson-Eads, Inc. ..... 2-3767, 2-8584, 3-4690


division of the National Fund for Medical Education.

J. W. Hamilton

Thomas C. Borland

**Thomas C. Borland** was elected vice president—production and a director of **Pan American International Oil Co. Jack W. Hamilton** will be resident manager at Tehran, Iran, for Pan American International.

**John T. (Jack) Doyle** was appointed to the top level staff position of assistant to the vice president in charge of **Shell Oil Company's** Pacific Coast area. Doyle replaces **William F. Bates,** recently named manager of Shell's Pacific Coast Production department.

**George J. Sallee** has been elected to the board of directors of **American Maracaibo Company,** whose name is to be changed to **Felmont Petroleum Corporation.** Sallee has been vice president of American Maracaibo since 1955 and has been actively engaged in the oil operations of the company's subsidiary, Felmont Oil, since 1947 in his capacity as vice president.

**The Tulsa Geological Society** has conferred honorary membership on **Mrs. Dollie Radler Hall,** consulting geologist; Tulsa, **E. F. Shea,** Pan American Petroleum Corp., Tulsa, **T. E. Weirich,** Phillips Petroleum Co., Bartlesville, Okla.; **S. W. Lowman,** Rensselaer Polytechnic Institute, Rensselaer, N. Y.; and Richard Hughes, independent, Tulsa. Mrs. Hall is the first woman geologist so honored by the Tulsa Geological Society.

**Gulf Oil Corporation** has announced the election of **Beverley Matthews,** a partner in the Toronto, Canada, law firm of McCarthy and McCarthy, to the board of Gulf.

**J. D. Wells** has been named chief production engineer, and **C. Clark Fuller, Jr.,** has been named staff engineer for **Pan American International Oil Co.** and will be assigned to the firm's New York City Office.

D. B. Kemball-Cook

**Denis B. Kemball-Cook,** a director and vice president of Shell Caribbean Petroleum Company, has been named executive vice president in charge of exploration and production for **Shell Oil Company.** Kemball-Cook will succeed **Alan J. Galloway,** who is retiring after 32 years with the firm.

**Frank Lindeman, Jr.,** will establish offices as a consultant to the petroleum industry in production matters. Lindeman resigned as vice president—production for Pan American Petroleum Corp.

**Joseph V. Heffernan** has been elected as a new member of **Tekoil Corporation's** board of directors. Heffernan is a vice president of the National Broadcasting Company.

**Standard Oil Company (New Jersey)** announced the appointment of **G. M. Knebel** to a newly created position of senior exploration advisor. He will be succeeded as manager of the Exploration division by **William E. Wallis,** who will be replaced as deputy manager by **Vaughn C. Maley,** regional geologist.

**Wilfred B. Tapper** has been named vice president of **Chaco Petroleum, S. A.,** Bolivian subsidiary of Tennessee Gas Transmission Company.

**Frank W. Beach** was appointed as division engineer for **Cities Service Oil Co.**

**W. Ross Moore** has resigned his position with Forest Oil Corporation and has established offices as an independent geologist in the Patio Building, Midland, Texas.

**Martin H. Mitchell** has been appointed general manager of **Tidewater Oil Company's** operations in Pakistan. From his headquarters in Karachi, Mitchell will direct oil exploration on concessions totaling 10,000 square miles in West Pakistan.


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what's Happening

# among INDUSTRY ASSOCIATIONS

## Houston NOMADs Discuss IGY

Commander J. R. Lumby of London, England, an authority on oceanography, spoke on the activities and the purposes of the International Geophysical Year before a recent meeting of the Houston NOMADs. International guests attending were (front row, left to right) R. M. Tufts, Socony Mobil, Venezuela; N. E. Rieter, Jr., Reed Roller Bit, Middle East; Commander Lumby, Texas A & M; and Albert Crownover, Southeastern Drilling Co. of Iran. (Back row) G. Prias, Shell Condor, Colombia; M. L. Cooper, A-Z Export Co., Colombia; L. L. Johnson, Atlantic Refining Co., Syria; Noah Berry, Southeastern Drilling, of Turkey; J. D. Haney, Southeastern Drilling, British Somaliland; Howard Archer, Southeastern, Turkey; and Kraus Earhart, The Texas Company.

## LA NOMADs Give Door Prizes

Winners of door prizes at the Los Angeles Chapter of Nomads Whing Ding held at the Lakewood Country Club recently are left to right, Tom Bell of The Texas Company; R. P. Armell of Eastman Oil Well Survey Company; Ben Brundage of Ben W. Brundage Company; Bob Craig of National Supply Company; Ed Embury of Guiberson Corporation; Frank Smith of BJ Service; Leo Langer of Western Perforating Company; Ken Johnson of Arden Farms; and Babe Doyle of Hydril Company.

W. D. Stuart

J. M. MacNicol

## Stuart, MacNicol Assume Canadian Oil Club Positions

The Canadian Petroleum Association announced the appointment of William D. Stuart as executive assistant to the general manager, John Proctor, of the association. Stuart joined the Canadian Petroleum Association as statistician in 1956.

The appointment of James M. MacNicol as statistician for the Canadian Petroleum Association was also announced.

## Houston Is Fall Site Of 1958 SPE Meeting

The thirty-third annual fall meeting of the Society of Petroleum Engineers will be held in Houston October 5-8. All official meeting activities will center around the City Coliseum and Music Hall.

Host for this year's meeting is the Gulf Coast Petroleum Section, whose chairman, Rupert C. Craze, Humble Oil & Refining Company, is also general meeting chairman. Honorary meeting chairman will be Irwin


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The Canadian Bank of Commerce maintains a complete Petroleum and Natural Gas Department in Calgary, and more than 270 branches throughout Western Canada. For information on any aspect of the industry in Canada, write or telegraph to C. H. Munro, Manager, Petroleum and Natural Gas Department, 309 Eighth Avenue, West, Calgary, Alberta.

(*We regret that we cannot advise on the merits of oil or mining securities.*)

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## Geophysical Officers

**Recently elected officers for 1958-59 of the Casper Geophysical Society are left to right: George L. Ellis, Pan American Petroleum Corporation, vice president; A. C. Austin, The Ohio Oil Company, president; and Barry W. Koch, Tidewater Oil Company, secretary-treasurer.**

W. Alcorn, Coastal-Marine Drilling & Construction Co.

Other committee chairmen include: Kenneth B. Ford, J. R. Butler & Co., registration; C. Marks Hinton, Oil Reserves Corp., finance; Gene L. Scheirman, Shell Oil Co., technical session arrangements; W. W. Cathriner, Hydril Co., entertainment; Mrs. M. Scott Kraemer, ladies activities; G. Flint Sawtelle, Kirby Petroleum Co., housing, and Clark Edgecomb, Schlumberger Well Surveying Corp., publicity.

## Rocky Mountain Geologists To Conduct Field Tour

The Rocky Mountain Association of Geologists will hold its annual field trip for 1958 in northwestern Colorado on September 18-20. The field conference will tour the Maroon Basin of northwestern Colorado to look at surface exposures of typical basin-center sediments and typical basin rim or shelf sediments with particular attention to interesting carbonate and hydrocarbon developments.

Registrations should be sent to Burton C. Dunn, Registration Chairman, 1150 Petroleum Club Building, Denver 2.

## N. M., Ariz. Geologists To Have Field Conference

The ninth annual field conference sponsored by the New Mexico Geological Society with the cooperation of the Arizona Geological Society will take place in the Black Mesa Basin of northeastern Arizona October 16 through 18. Registration and caravan organization will be at Gallup, N.M., October 15. The conference will deal with the general geology, stratigraphy, structure, economic geology and water resources of the Black Mesa Basin.

Write to Richard D. Holt, field conference general chairman, P. O. Box 1116, Roswell, N. M., to contribute articles for the guide book or for additional information.

## N. Y., N. J. Oil Men Give Aids to Public Schools

The New York-New Jersey Oil Information Committee placed American Petroleum Institute classroom aids in a total of 1,040 schools in Upstate New York, Metropolitan New York and New Jersey. This is free and non-commercial material to assist students in their study of petroleum and its effects upon modern science, society, industry and the nation's economy.

## What's Happening

# among SERVICE and SUPPLY MEN

John Maher

Ray O. Shaffer

**Reed Roller Bit Company** elected a new chairman of the board, a new president, three new directors and announced the retirement of **Rex G. Hamaker,** director and president of the company. **Ray O. Shaffer,** president of Welex, Inc., Fort Worth, Texas, was elected a director and will serve as chairman of the board of directors of the company. **John F. Maher,** formerly president of Oil Center Tool Company, Houston, was elected a director and new president of Reed Roller Bit. **A. H. Rowan,** chairman of the board of directors of Rowan Drilling Company of Fort Worth, Texas, is the other new director elected. The board members remaining on the board are **John H. Blaffer, S. P. Farish, Claud B. Hamill, J. W. Link, Jr., John Mecom** and **Wharton Weems.**

**Stewart & Stevenson Services, Inc.,** has made five promotions and new assignments in West Texas. **Grady Foster,** who has been sales manager in the Lubbock territory, has been promoted to branch manager in charge of the entire Lubbock operation. **Bob Wassom,** parts manager at Lubbock, is now operations manager of the Lubbock branch. **Dick Brough,** who has been operations manager at Lubbock, has been promoted to district operations manager, and will maintain headquarters in the Odessa branch. **Louis Duncan,** formerly field representative in the Lubbock area, has been reassigned to the Odessa territory and is now general field salesman. **Dave Klager,** formerly operations manager at Odessa, has been transferred to the eastern half of the Odessa territory which includes Midland and Abilene. He is a field sales representative.

E. H. Clark, Jr.

W. S. Althouse, Jr.

G. D. Hall

Paul E. Hilton

**Baker Oil Tools, Inc.,** announces the appointment of **E. H. Clark, Jr.,** as vice president and assistant general manager, to carry out assigned administrative functions at Los Angeles. Clark formerly was head of the Research department. **W. S. Althouse, Jr.,** recently elected a member of the board of directors, was named manager of engineering and research. Althouse formerly held the title of chief engineer. **G. D. Hall,** assistant secretary-treasurer,


# Tri-State Oil Show

**ROBERTS MUNICIPAL STADIUM — OCTOBER 9, 10, 11 and 12, 1958**

**EVANSVILLE, INDIANA**

"The Oil Capitol of the Midwest"

## Sixth Annual Tri-State Oil Show:

**EXHIBITORS:**

Exhibit Space Inside Stadium.
Open Spaces on Paved & Unpaved Surfaces Outside Stadium.
Tented Spaces, Outside Stadium.
Open House—Thursday Evening, Oct. 9, 1958 for Exhibitors and their guests only (Admittance by invitation only—closed to public.
Dinner, social hour and entertainment.

**CONVOY TO PERMIAN BASIN OIL SHOW—ODESSA, TEXAS, from TRI-STATE OIL SHOW Leaving at daylight, Monday morning, October 13, 1958. Plenty of time to reach Odessa to set up exhibits.**

**ENTERTAINMENT: Top Television Entertainers for all ages.**

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and formerly assistant manager of the Central division, was appointed administrative director of the Baker Houston plant. **Paul E. Hilton,** newly elected vice president and a member of the board of directors of Baker Oil Tools, Inc., will continue as manager of sales and service, Central division.

**R. B. Pratt** was recently named vice president of the **Petty Geophysical Company.** Pratt is now in his 25th year with the company.

**Howard H. Ferrell** joined the Production Engineering division of **Gulf Research & Development Company** and was assigned to work with the Drilling section during the summer. He returned to Texas A & M to complete his Ph.D. in petroleum engineering this month. **O. Gerald Kiel** joined the Production Engineering division of Gulf Research as a research engineer for the summer. **Jay C. Karp** also joined the Production Engineering division of Gulf Research as a research engineer.

**Arthur M. Hazell, Jr.,** was appointed manager of petroleum equipment sales for Electro-Motive division of **General Motors.** Hazell, who is headquartered in Houston, succeeds **Harold P. Gustavson,** formerly headquartered in Dallas, who has been transferred to the home office in La Grange, Ill. Hazell will be assisted by two factory service engineers—**Thurlow Fernandez** at Houston and **Ed Chernoff** at New Orleans.

**James A. Gobel, Jr.,** of Odessa, Texas, has been named assistant executive-secretary and field representative for the Association of Oilwell Servicing Contractors. Gobel has had five years experience in the oil supply industry and production equipment in the Permian Basin. For the past year he has managed the W. C. Brown Pipe and Supply Co. of Crane, Texas.

J. A. Gobel, Jr.

**Milwhite Mud Sales Company** announced the following appointments. **Gilbert Pollard** was appointed to the position of sales manager. He has been a member of the Sales department for the past five years. **Robert A. Jung** was appointed to the position of manager of engineering. Jung has been associated with the drilling mud industry since 1942 and has acted in the capacity of engineering coordinator for Milwhite.

W. H. Sargent

**W. H. (Bill) Sargent,** vice president, **Sargent Engineering Corporation,** has been appointed director of oil tool sales. Sargent previously was in charge of the foreign oil tool sales, advertising and public relations since 1948. He replaces **H. L. Sargent.**

**HOMCO** has announced several transfers. **Jack Brothers** has moved from office manager, Billings, Mont., to Kimball, Neb. **Wm. H. Dodson, Jr.,** has moved from field salesman, Bay City, Texas, to assistant store manager, Beaumont, Texas; **Robert E. Duke,** from executive assistant of directional drilling to executive assistant of marketing; **L. M. Ebeling,** from fishing tool supervisor, New Iberia, La., to district manager, Pampa, Texas; **Robert C. Evans,** from office clerk to assistant store manager; **Jack Morgan,** from Farmington, N. M., to fishing tool supervisor, Casper, Wyo.; **Charles H. Pollard,** from Lafayette, La., to manufactured products, Houston; and **Robert Thomason,** from Kimball, Neb., to Casper, field salesman.

**Continental-Emsco Company** announced the following appointments and changes in personnel for their Canadian operations. **Walter Chayka** is the newly-appointed store manager for Continental-Emsco's supply store at Virden, Manitoba. **Joe Belk,** former division D + B specialist, has been appointed to division production equipment specialist. Belk will continue to headquarter in Calgary. Appointed to the position of sales engineer, **John E. Campbell** will also be stationed in Calgary.

**Cameron Iron Works, Inc.'s** Domestic Oil Tool division has announced the transfer of **Warren W. Hinton** to sales and service at Brookhaven, Miss.


"On Location" Laundry equipped with

MILNOR

REG U.S. PAT. OFFICE

STAINLESS STEEL WASHER and STAINLESS STEEL EXTRACTOR!

MILNOR WASHERS
Sizes: 25-lb., 50-lb., 75-lb., and 100-lb. Manual, Semi-Automatic, Fully Automatic with Supply Injection.





MILNOR EXTRACTORS
Sizes: 20", 26" and 30". Manual, Automatic Timer, Automatic Brake Models, Laundry and Dry Cleaner Types.

The Rimrock Tidelands, Inc., *"Rimtide"* in the Gulf of Mexico is equipped with a MILNOR Stainless Steel Washer and a MILNOR Stainless Steel Extractor.

*"On Location" Laundry has these advantages:*

1. More conveniences
2. Smaller linen inventory required
3. Quick availability of linen when you need it.

INQUIRIES INVITED
*Write Today!*

PELLERIN MILNOR CORPORATION
P. O. BOX 7313, NEW ORLEANS 19, LA.

*Choose . . .*

# REDA

## PUMPS FOR HIGH WATER-OIL RATIO WELLS

High capacity Reda Pumps produce fluid volumes up to 18,000 barrels per day from standard size casings. You can profitably produce wells with a high water-oil ratio. Investment cost per barrel of daily capacity is far lower when you choose REDA for high water-oil ratio wells.

### INCREASE YOUR *PROFITS* WITH REDA SUBMERGIBLE ELECTRIC PUMP ADVANTAGES:

- **Lower cost for installation, operation and maintenance**
- **250 to 18,000 BPD capacities**
- **Depths to 10,000 Feet**
- **Corrosion-resistant construction**
- **Long life — dependable service**
- **Flexibility to meet changing requirements**

*Write or call for more information. Reda engineers will be pleased to assist and help plan your operations.*

SIGN OF QUALITY SUBMERGIBLE REDA PUMPS

**REDA PUMP CO.**
BARTLESVILLE, OKLAHOMA

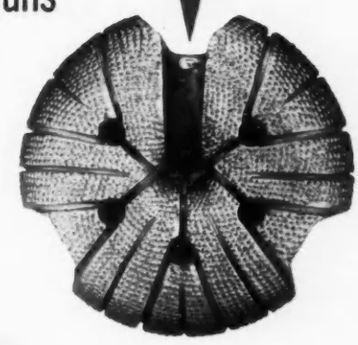
Manufacturers of submergible motors and pumps for over 35 years — for oil, brine and water wells, gasoline and jet fuel —



HYCALOG

# ANNOUNCING

For long uninterrupted runs in hard formations



# V-DOOR DIAMOND DRILL BITS

PATENT APPLIED FOR

Another dividend you receive from Hycalog's continuing research program

**Already Breaking Records** for making hole in the deep Bromide sands of Oklahoma, the V-Door bit incorporates a new concept in bit design . . . *exclusive with* Hycalog.

To prevent plugging of the center section . . . *a common problem with conventional diamond bits* . . . the new Hycalog bit actually cuts a small core. Then, by a combination of hydraulics and bit design, the core is broken off in short segments and washed through the V-Door slot out of the hole. As a result of this design, far more hole per trip than ever before possible has been made in these extremely hard formations.

*Ask your* Hycalog *representative for performance records of* V-Door *bits.*

**Hycalog, Inc.**

505 AERO DRIVE
SHREVEPORT, LOUISIANA

BRANCH OFFICES IN PRINCIPAL OIL PRODUCING AREAS

DIAMOND CORING • DIAMOND BITS • WELL LOGGING • CORE ANALYSIS

**Andre Blanchard** has been named vice president — technique —by the directors of **Schlumberger Well Surveying Corporation.** Since joining Schlumberger in 1943, Blanchard has been head of the Engineering department. He was elected vice president, engineering, in 1951. In his new position he will be in charge of the entire research and engineering program of the corporation.

Andre Blanchard

**Ed Rhodes** has been named manager of **Black, Sivalls & Bryson, Inc.,** Farmington Oil Field district. Rhodes succeeds **Joe Beggs,** who has managed the Farmington district for the past year. Beggs will devote full time to the promotion and sale of dehydration and other process equipment in the Four Corners area.

**George P. Lacy** has been appointed vice president and general sales manager of wire and wire rope products at **Union Wire Rope Corporation,** subsidiary of Armco Steel Corporation. **L. G. Schraub,** who had been vice president and general sales manager since 1938, has retired from active duty with the company. He will continue however on a consulting basis with Union Wire Rope Corp.

Samuel S. Smith

Ray Armstrong

**Samuel S. Smith** has been named regional sales manager of the newly activated Rocky Mountain Sales region for the Pumping Unit division of **The Parkersburg Rig & Reel Company.** Smith, who previously was in charge of pumping unit sales in the Canadian division, will headquarter in Denver. Replacing Smith in Canada is **Ray Armstrong,** who was transferred from the Fort Worth, Texas office.

**Charles E. Decker, Jr.,** has been appointed wire rope engineer, **Bethlehem Steel Company,** with headquarters at the company's Tulsa office. He replaces **T. H. Gibbs** who has been appointed wire rope salesman, Tulsa office.

**Robert W. Eiler** and **A. R. Meyer** have been elected vice presidents of **The National Supply Company.**

**Paul D. Moon** is new manager of sales promotion at **Broderick & Bascom Rope Co.**

**W. Clark Root** has been named the new president and chief executive officer of **Graver Tank & Mfg. Co. Jalmer E. Swason,** former president of Graver, has moved to the post of vice chairman of the board. Root joined Graver Tank in April, 1958, as executive vice president. Previously he was project manager for Canadian Bechtel, Ltd.

W. Clark Root

**Norvell-Wilder Supply Company** announced the appointment of **John W. Petrelli** as assistant branch manager of the Fort Worth branch. Petrelli, who has been in the industrial supply field for six years, will manage industrial sales in the Fort Worth-Dallas area.

**Jack K. Sutter** has been appointed manager of tubular sales for **The National Supply Company.** He succeeds **Charles J. Ramsburg, Jr.**

**J. T. Lewis** has been transferred to Midland, Texas, as division sales manager for **Kobe Hydraulic Pumping Systems.** Lewis who has been with Kobe for over 20 years returns to West Texas where he was stationed before going to Houston as Kobe division sales manager.

**S. D. Flinn** has been named assistant to president of **United States Steel Supply Division, John H. Morava,** president, announced.


## New JENSEN Rotary Balanced JACK offers:

### SAFE, EASY RACK-AND-PINION COUNTER BALANCE

. . . Just one man—standing on the ground—can adjust the new Jensen Rotary Counterbalance. Unique Jensen rack-and-pinion system assures speedy weight adjustments, gives both lead and lag counterbalance. And Jensen Rotary Jacks are simple to install on flat concrete surfaces or on simplified steel skids—to make your well easier and less costly to equip.

Send now for your copy of our catalog, fully describing the new Jensen Rotary Series and the famous Beam-Balanced Line.

**STOCKED BY YOUR LOCAL SUPPLY STORE**

**Made by JENSEN BROS. MFG. CO., INC., P. O. Box 477-D, Coffeyville, Kansas**
**Export Office: 250 Park Avenue, New York 17, N. Y.**

**JENSEN JACKS**

## Cable Engineering Enlarges Name to Cable & Stephens

Fred Stephens

Cable Engineering, consulting petroleum engineers, Wichita Falls, Texas, has changed its name to Cable & Stephens. Partners are Jo H. Cable and Fred Stephens. Stephens joined the firm in 1949 and became a partner in January, 1957. The firm has been active in consulting petroleum engineering for more than 30 years.

## Atlas Powder Co. Dedicates $3 Million Technical Center

Atlas Powder Company recently dedicated its new Technical Center in a short ceremony at the company headquarters in suburban Wilmington. The $3 million facility, located next to the company's general office which was opened three years ago, will house the company's basic research and chemical product development activities.

## H. K. Porter Company Opens New Office in Pennsylvania

Two divisions of H. K. Porter Company, Inc., Quaker Rubber and Leschen Wire Rope—have opened a joint sales and service branch office in New Kensington, Penn., to serve West Virginia, eastern Ohio and western Pennsylvania. It provides added office space and combined warehouse facilities for both divisions.

## PGAC Is Establishing Oil Field Service Operations in Bolivia

Establishment of oil field service operations in Bolivia is announced by Perforating Guns Atlas Corporation, Houston subsidiary of Chemetron Corporation (formerly National Cylinder Gas Company).

The new overseas activity is being started under contract with Yacimientos Petroliferes Fiscales Bolivianos, Bolivian government oil company. Headquarters will be at Camiri and the company will serve the Bolivian oil fields which extend approximately 150 miles along the eastern side of the Andes mountains.

Eugen Kindje has been appointed chief engineer for the Bolivian operations which are to be conducted as a division of Servicios Tecnicos Atlas, CA, the PGAC's oil field service subsidiary in Venezuela. Eduardo Sotello has also been named to the Bolivian division's engineering field staff.

## TI Dedicates New Dallas Plant Using Signal From Vanguard

Texas Instruments Incorporated dedicated its new 310,000 square foot plant of revolutionary design for the manufacture of transistors and other semiconductor devices on a 300-acre site recently in Dallas by using the signal from the American satellite Vanguard to cut the traditional ribbon.

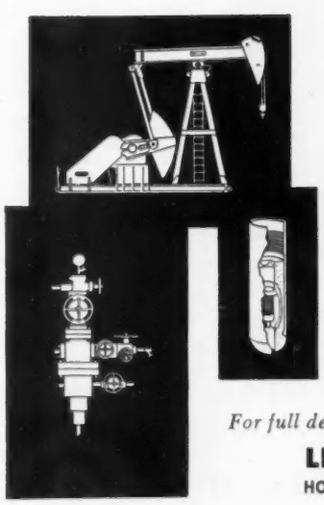
Dr. James R. Killian, chairman of the president's Advisory Committee on Science, made the dedicatory address. Dr. Killian, who is on leave from the presidency of Massachusetts Institute of Technology, also pressed the button which completed the circuit activating the electronic ribbon-cutting device with a predetermined "beep" signal from the satellite.

## *Griffin Tank Supplies Geophysical Equipment*

**A major U. S. oil company has placed a million dollar order for geophysical equipment to explore the Libyan Desert bordering Egypt. The highly specialized geophysical equipment pictured is built by Griffin Tank and Welding Co. All units are being installed on six-wheel drive International diesel trucks. Special oversized wheels with 12-ply nylon aircraft type tires by Texas Tire Service of Weatherford, Texas, provide low pressure traction in the desert sands.**

**"This ain't my kind of Pumping!"**

**says Mike LE GRAND**



who knows a thing or two about pumps and well-head equipment, 'cos he's in for a trouble-free time when Le Grand equipment is in use. Rugged—dependable—built to do its job under all conditions - with a unit to take every kind of load. Also available: LeGrand OCT. Well-head Equipment; LeGrand Howco Floating Equipment; and LeGrand-S.C. Carter Long-stroke Hydraulic Pumping Units.

*For full details, please write to:—*

**LE GRAND ROCHESTER LIMITED**

HORSTED AIRPORT, ROCHESTER, KENT, ENGLAND

Telephone: CHATHAM 44626

*Also represented in the following countries:—*

CANADA, TRINIDAD, VENEZUELA EASTERN, VENEZUELA WESTERN, IRAQ



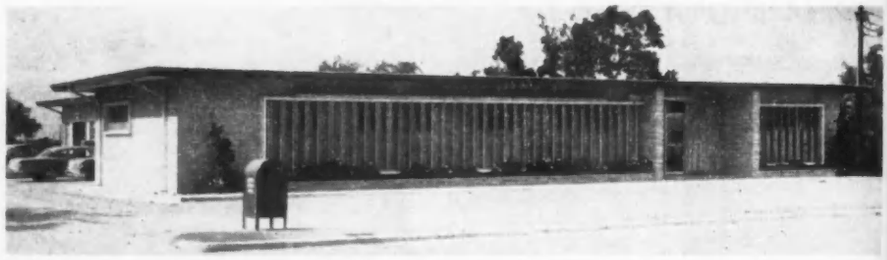

For more data on advertised products, use Readers' Service Cards, last page.

## Sun Electric Corporation Buys Panel Instruments Line of TI

Texas Instruments Incorporated announced that it has disposed of its panel instruments manufacturing facilities and product line to the Sun Electric Corporation of Chicago. Under terms of the transaction, Sun Electric will provide service to all former Texas Instruments panel instrument customers.

Texas Instruments announced that it had discontinued its panel instrument manufacturing activity to devote the space and effort involved to other phases of its expanding electronics development and manufacturing activities.

Terms for the sale of facilities and product line to Sun Electric were not disclosed.



## *Geophysical Associates Has New Home*

**Geophysical Associates International has occupied a new headquarters building in Houston, which contains 9,000 square feet of floor space. The building is divided into sections for administrative, stenographic, drafting, mapping, magnetic, equipment research and assembly, supply and storage.**


BRITISH MADE

# 300 P.A. TRACTOR DRILLMASTER

## MULTI-PURPOSE · HIGHLY MOBILE

The Hands-England Drillmaster 300 P.A. Rotary Drill is now available mounted on a Fordson Major Tractor and is illustrated on left.

This design provides great manoeuvrability and is intended primarily to enable the well known H-E Drillmaster 300 P.A. Rotary Drill to be used for Quarry and Open Cast blast or shot holes.

Although the H-E Drillmaster 300 P.A. mounted on a diesel engined tractor, is ideal for Quarry and Open Cast operations, it is equally applicable to some difficult "off the road" locations, such as may be encountered during seismic exploration particularly in highly cultivated areas.

An air compressor giving 99 C F M can be mounted directly onto the drill subframe and driven from the tractor engine. This compressor gives an up-hole annular velocity of 3,000 ft./min. when using flush jointed drill pipe and holes of the following sizes:

| | | |
|---|---|---|
| 1⅝" o/d. Drill Pipe | 2⅞" | dia. hole |
| 1.29/32" " | " | 3½" " " |
| 2⅜" " | " | 3⅝" " " |
| 2⅞" " | " | 3¾" " " |

Larger holes or holes drilled with mud circulation can of course be drilled, but the equipment for these operations must be mounted on a separate trailer or tractor.

The H-E Tractor Drillmaster will be found to cover the majority of drilling requirements of the Quarry and Open Cast operator, the Geologist, the Mineralogist, and the Geophysicist.

Write for illustrated folders giving full details and specifications of this equipment.

**HANDS-ENGLAND OILFIELD EQUIPMENT LTD**

MANUFACTURERS OF GEOPHYSICAL SUPPLIES

**LETCHWORTH HERTS ENGLAND TEL: 600 CABLES: OIL LETCHWORTH ENGLAND**

Exclusive licensees in Western Germany: August Goettker Flachbohrungen, 20a Wathlingen Kreis Celle, West. Germany


## Borg-Warner Occupies Space In Chicago Namesake Building

The Central office of Borg-Warner Corp. was moved to the new Borg-Warner building in Chicago. The corporation, which vacated space in the Continental Companies building after a stay of almost 30 years, took over the top three floors of the new building. Later the company will also occupy additional rooftop quarters which will be used for conferences and meetings.

Chicago's newest skyscraper was named after Borg-Warner because the corporation is the building's principal tenant. The company, however, has no financial interest in the structure.

## Hudson Engineering to Handle Product Sales of BS&B, Inc.

Hudson Engineering Company of Birmingham, Ala., and North-Monsen Company of Salt Lake City, Utah, have been appointed manufacturers' representatives for BS&B controls, safety heads and tank vents.

## ACF Moves Executive Offices Into Newer Headquarters

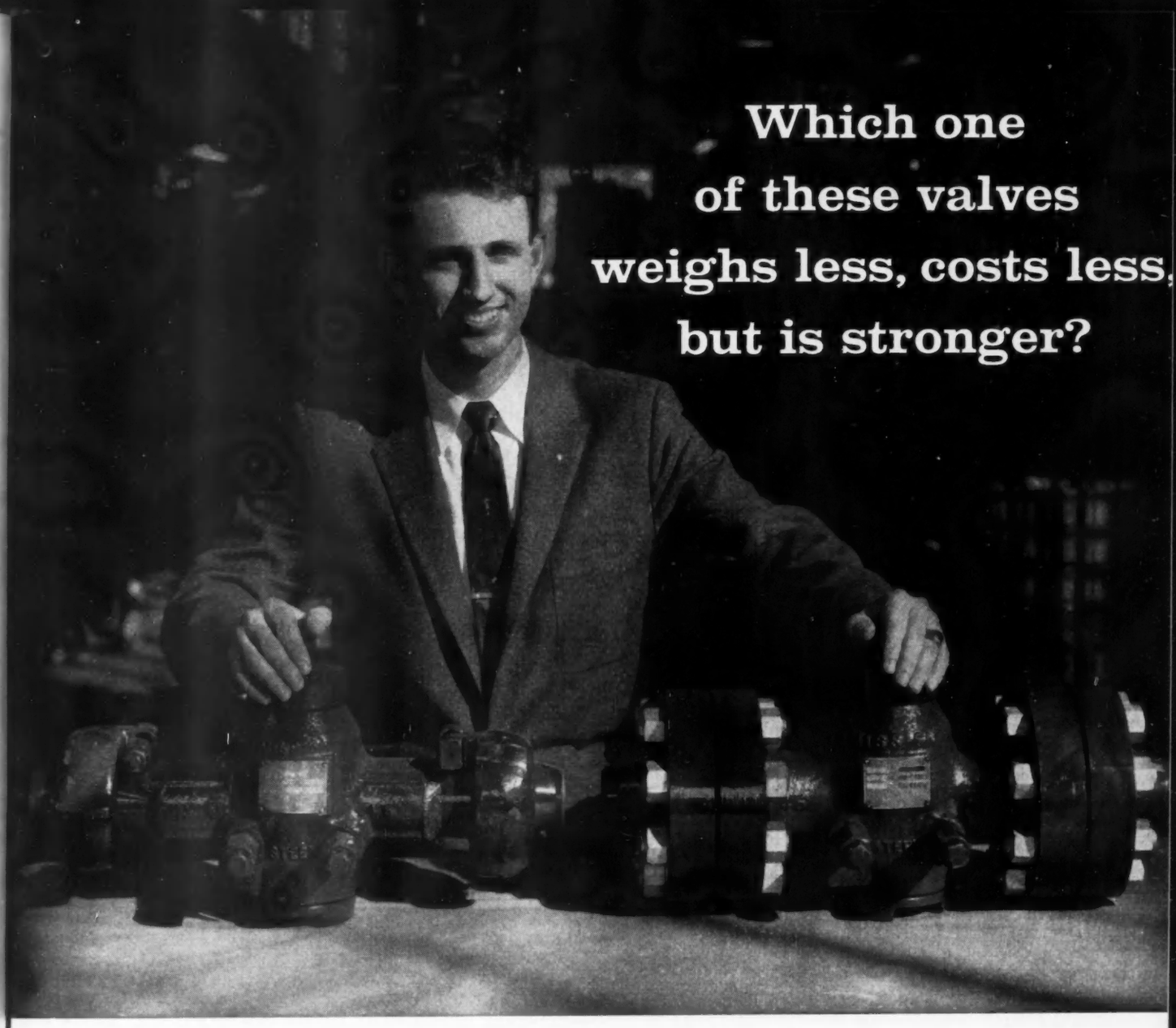
ACF Industries, Incorporated, is moving its executive offices this week to 750 Third avenue, New York, after 32 years in the Hudson Terminal Building at 30 Church street. Also involved in the move are the home offices of three of ACF's operating divisions—Advanced Products, American Car and Foundry and Shippers' Car Line.

## Service Bulk Mud Becomes Part of Baroid Division

The integration of the Service Bulk Mud Company of Liberty, Texas, and its personnel into Baroid Division National Lead Company has been announced by the Baroid general offices at Houston. V. R. Burch, organizer and previous owner of Service Bulk Mud Company, joins Baroid Division with over 29 years of experience in mud distribution in the Texas Gulf Coast area.

## Great Lakes Petroleum Services To Increase Wireline Units

Great Lakes Petroleum Services, Inc., a wholly-owned subsidiary of Great Lakes Carbon Corporation, will expand its wireline units by 50 percent during the next six months, it was announced by J. T. Hancock, Jr., president of the subsidiary, and Manly B. Brown, vice president of marketing for the parent company.



# Which one of these valves weighs less, costs less, but is stronger?

Both of these valves are of the same make, model, size, and pressure rating. One is equipped with 2″, 6000 lbs. test, Unibolt Couplings, the other with 2″, Series 900 flanges. The Unibolt-equipped valve weighs 102 lbs. less, costs about 10% less, and is approximately 28% stronger!

And the advantages don't stop there. Because it weighs less, the Unibolt-equipped valve costs less to ship and is easier to handle, easier to install. (Two bolts and nuts, compared to 16 bolts and 32 nuts.)

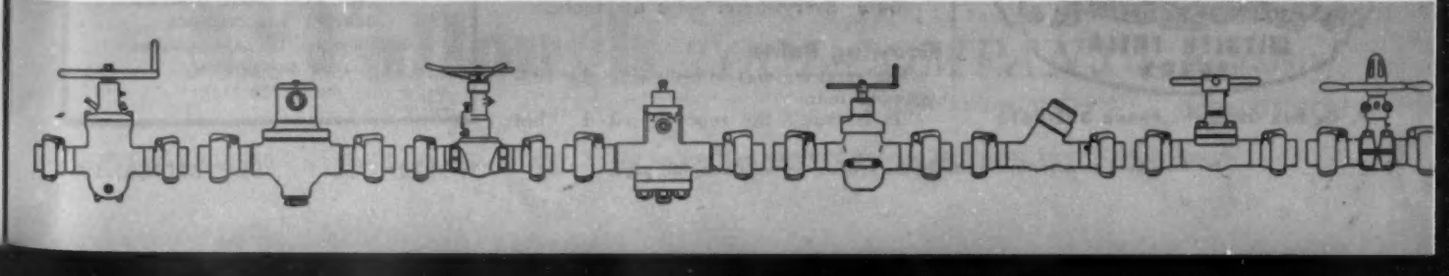
Unibolt Couplings are easy to attach to any valve. Either hub of the Coupling may be butt-welded, socket-welded or screwed to the valve body.

Even if steel were plentiful, Unibolt-equipped valves—as opposed to flanged valves—would be your best buy.

**THORNHILL** UNIBOLT **CRAVER CO.**

**P. O. Box 1184, Houston, Texas**

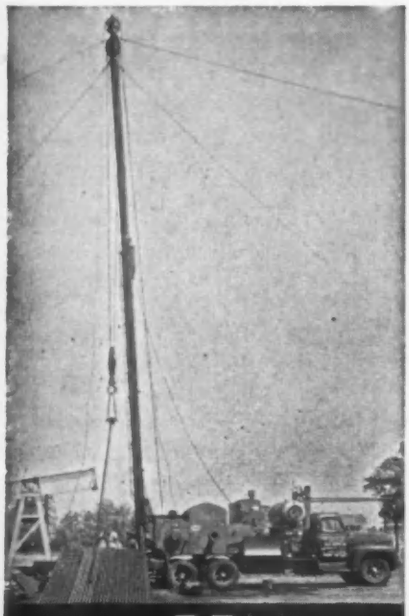
## ask your supplier to furnish unibolt-equipped valves



*Here's Your*

# TOP VALUE

**IN SERVICING UNITS**



**WICHTEX**

**Well Servicing Units**

**Wichtex Units provide what the service-wise, dollar-wise contractor looks for:**

**. . . top capacity with mobility**
**. . . fast, simple operation**
**. . . easy upkeep**
**. . . low operating costs**
**. . . long economical life**

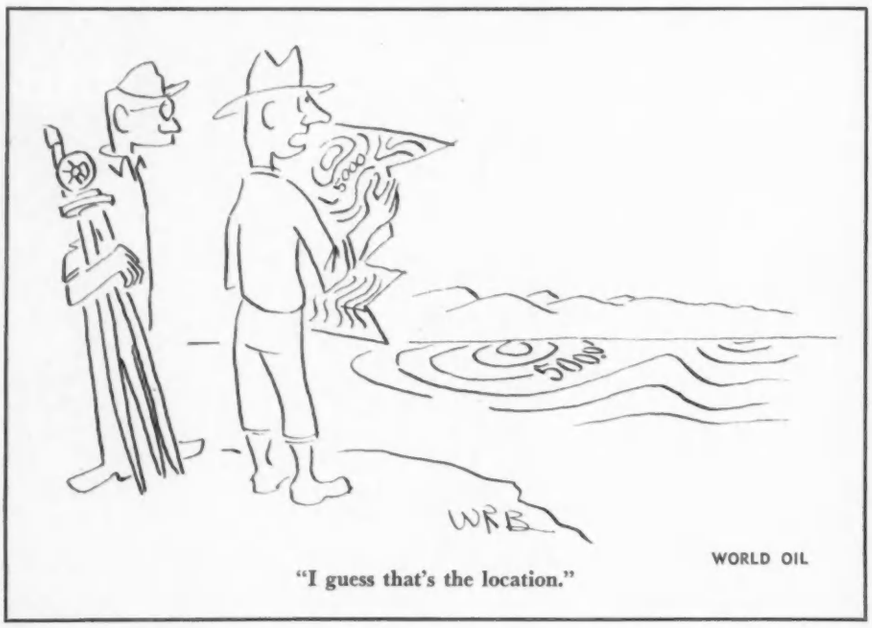
**Here is your TOP-VALUE line of well servicing units. Available in eight models for 2,000′ to 12,000′ capacity. Spudding attachment optional.**

**Also investigate Wichtex Rotary Rigs for 2,000′ to 5,000′ drilling.**

WICHTEX MACHINERY COMPANY INC. WICHITA FALLS TEXAS

**P. O. Box 2250 Phone 322-8612**

## SQUEAKS from the BULLWHEEL




"I guess that's the location."

### Sure Cure

"I understand that Mimi has cured her Scotch boyfriend of stuttering. How did she do it?"

"She called him up long distance collect."

### Living Off the Land?

One farmer asked his neighbor the age-old question. "How's crops?"

"Waaal," he drawled, "the filling station and hot dog stand ain't doin' so good, but they'll hold us over to spring when we open our drive-in theater."

### Cheaters Never Win

Pete—"It's funny how Ed is so lucky at cards and then loses his winnings at the race tracks."

Emil—"Funny, nothing. They won't let him shuffle the horses."

### Hospitality

Much chagrined at being arrested, a man staggered into the police station and, before the captain had an opportunity to say anything, pounded his fist on the desk and announced. "What I wanna know is why I've been arrested."

"You were brought in for drinking," the captain answered.

"Splendid!" replied the citizen. "Let's get started."

### Young Sophisticate

"Do you know where bad little girls go?" the psychiatrist asked the four-year-old.

"Sure. Everywhere!" was the reply.

### Growing Pains

The reporter was interviewing the 103-year-old man.

"Is it true," the reporter asked, "that your 84-year-old son eloped with your housekeeper?"

"I'm afraid it is true," the old man answered soberly. Then he added apologetically, "He's just a crazy, mixed-up kid."

### No Bachelors

"Four years of college," sighed the girl graduate, "and whom has it got me?"

### An Odd Joke

The two lisping boys were sitting at the bar, holding hands. A man and a woman seated near them began arguing furiously.

Finally, the man strode away from the woman, approached the bartender and said angrily. "Give me my check and let me pay up and get out of here before I punch that dame right on the nose."

One boy nudged the other and simpered smugly, "You see! Those mixed marriages never work."

SECONDARY RECOVERY
Since 1922

PETROLEUM ENGINEERS
CABLE & STEPHENS
WICHITA FALLS, TEXAS

**RESERVOIR ENGINEERING**
**Water Flooding Gas Repressuring**
EVALUATION CORE ANALYSIS
SURVEYS ECONOMICS
Cost Estimates, Design, Installation
FIELD SUPERVISION
Phone 723-2167

Over
70
*Locations in the United States and Canada*

# McCullough® REPORTS TO THE OIL INDUSTRY

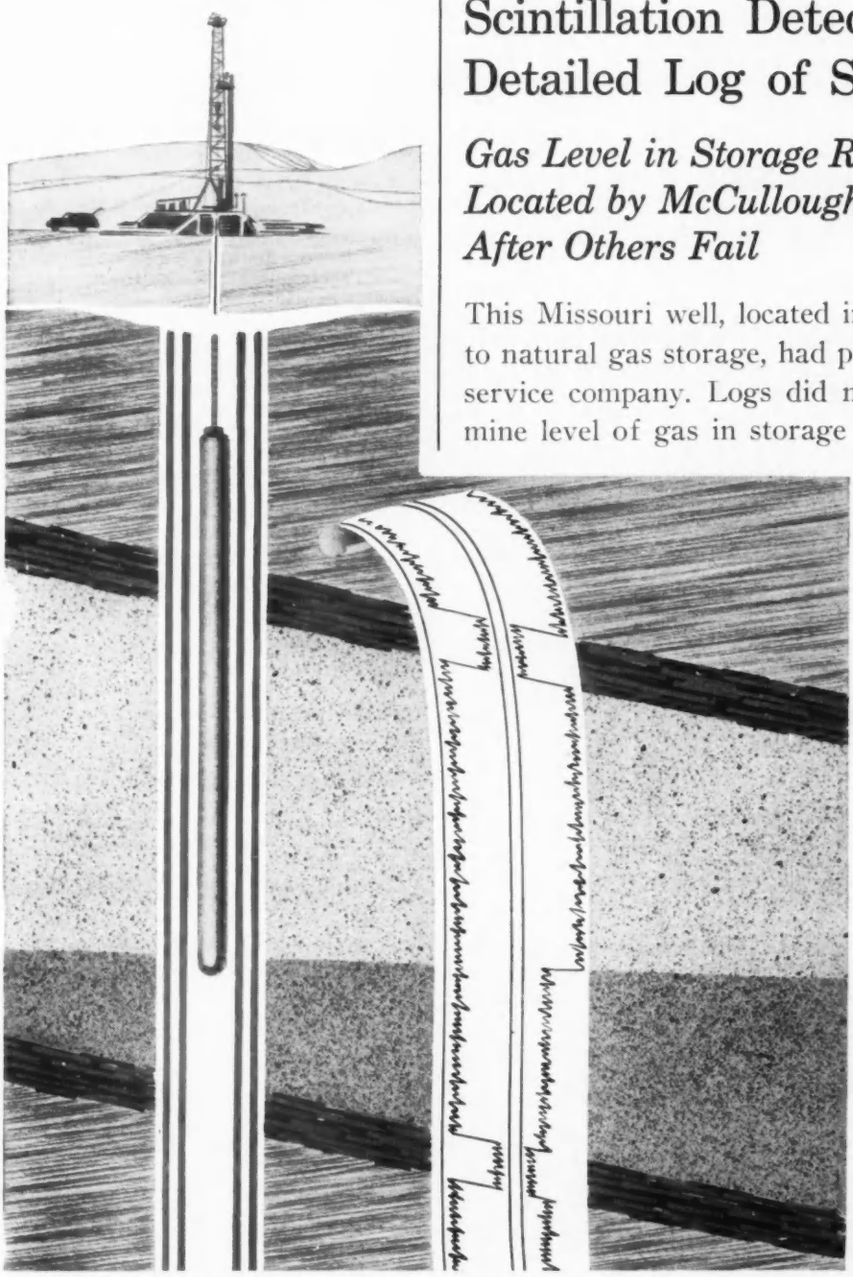
Service
*Anywhere Anytime*

*New Services • • • New Tools • • • New Methods • • • Outstanding Results*

## Scintillation Detector Provides Detailed Log of Storage Reservoir

### *Gas Level in Storage Reservoir Accurately Located by McCullough Radiation Well Logger After Others Fail*

This Missouri well, located in a field that had been converted to natural gas storage, had previously been logged by another service company. Logs did not show enough detail to determine level of gas in storage reservoir.



Scintillation Detectors, used in McCullough down-hole logging instruments, have an efficiency approaching 100% in detecting and measuring nuclear radiations.

McCullough ran both 5″ = 100′ and 2″ = 100′ scale combination Gamma Ray-Neutron Logs. The clear, accurate detail of the curves showed the exact level of gas in storage. Operator was very pleased with the successful outcome of the job.

The success of this logging operation was not an isolated instance. Later, another well in the same field, previously logged by two other service companies without results, was relogged with McCullough's Radiation Well Logger—again obtaining reliable, accurate Gamma Ray and Neutron Curves.

**The job shown above is certified to be a true field report of service rendered.**

**McCullough® TOOL COMPANY**

*Cable Address:* MACTOOL

LOS ANGELES
HOUSTON
EDMONTON



For more data on advertised products, use Readers' Service Cards, last page.

### Don't Drink It, Tho

Professor: "Give the chemical formula for water."

Student: "HIJKLMNO."

Professor: "Are you trying to be funny, young man?"

Student: "No. You told us that water is H to O."

### Touche

A tramp knocked on the door of the inn known as "George and the Dragon." The landlady opened the door and the tramp asked: "Could you spare a hungry man a bite to eat?"

"No!" replied the landlady, slamming the door in his face.

A few minutes later the tramp knocked again. The landlady came up to the door again. This time the tramp asked, "Could I have a few words with George?"

### Compensation

"For a man with no experience, you're certainly asking a high wage," the prospective employer said to the applicant.

"Well," rejoined the applicant, "it's much harder to work when you don't know what you're doing."

### Keeping an Eye Open

Mother: "Tommy, what are you doing, darling?"

Little Boy: "Nothing much, mom. With you and God and Santa Claus watching all the time, I can't do much."

### Fun in the Sun

"Was Maybelle a success at Palm Beach?"

"Oh yes, she got along swimmingly. In fact, she managed to outstrip all the other girls."

### This Is Progress?

The youngster came home from school and announced: "They've got a magic record player at our school."

"A magic record player?" asked his mother, puzzled.

"Yes," he explained. "You don't need electricity—you don't plug it in to play. All you have to do is wind up a crank!"

### Not Enough Caution

Young son: "Dad, Mom just backed the car out of the garage and ran over my bicycle."

Dad: "Serves you right for leaving it on the front lawn."

### Auditing the Course

The professor said, "You in the back of the room. What was the date of the signing of the Magna Charta?"

"I dunno."

"You don't, eh? Well, can you tell me who Bonnie Prince Charlie was?"

"No."

"Well, maybe you can tell me what the Tennis Court Oath was?"

"Nope."

"You can't? I assigned that last Friday. Where were you?"

"I was out taking the day off with some friends."

"Oh, you were, were you? Do you expect to pass this course?"

"Well, I don't suppose so, mister. I just came in to fix the radiator."

### Catching Up

Women find themselves at quite a disadvantage since man can now travel faster than sound.

### Privilege

She: "I've lost so much weight you can count my ribs."

He: "Gee, thanks."

### Narrow Minded

First girl: "How do you like your new boss?"

Second girl: "He's nice all right, but he's bigoted?"

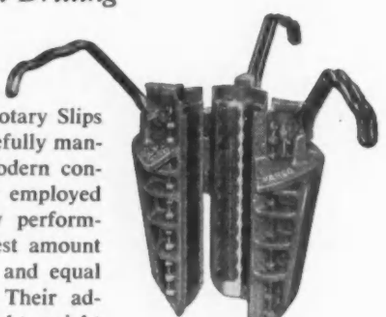
"What do you mean by bigoted?"

"Well, he's the kind that thinks words can be spelled only one way."

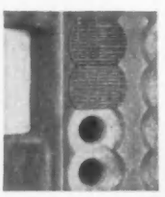
VARCO

**Type SRL-Long Rotary Slips Provide the—Long Life—Safety—Low Maintenance Costs Needed for the Deepest Drilling!**

*Type SRS—Short Rotary Slips Available for Shallow to Medium Drilling*



VARCO type SRL-Long Rotary Slips are especially designed, carefully manufactured and the most modern controlled heat treatments are employed to produce highest quality performance. They have the greatest amount of line contact per weight and equal size of any Rotary slips. Their advanced design combines light weight with high ultimate strength to provide the greatest possible protection for deep drilling.



**FIRM HOUSING OF BUTTONS IN INDIVIDUAL COUNTERBORES** integral to the slip body prevents wear and danger of elements falling into the hole.

**SHALLOW TOOTH BUTTONS** reduce penetration to the minimum. The gripping element renders maximum line contact.

**Only VARCO Rotary Slips incorporate all these advanced principles.**

**1.** Shallow tooth gripping element with maximum line contact and minimum penetration. **2.** All gripping elements individually, firmly and safely housed in counterbored slip bodies. **3.** Self-aligning hinge blocks. **4.** Forged and heat treated alloy steel handles. **5.** Maximum strength. **6.** All component parts of VARCO Rotary Slips are made from selected alloy steel and they are subjected to multiple heat treat operations to obtain maximum strength and toughness.

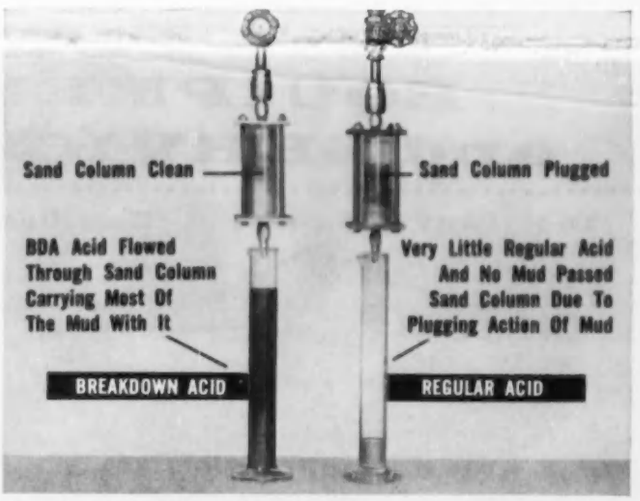
*See Our Section in The Composite Catalog or . . .*

***Write for new catalog!***

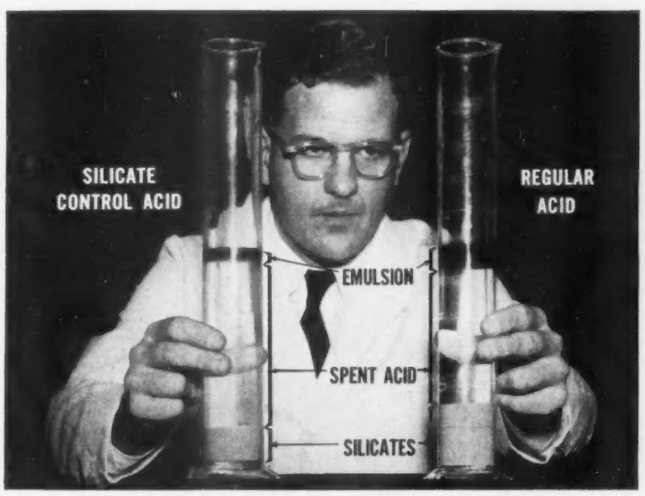
Abegg and Reinhold Co.

2533-2541 East 26th Street, Los Angeles 58, Calif.
HOUSTON, TEXAS • OKLAHOMA CITY, OKLAHOMA

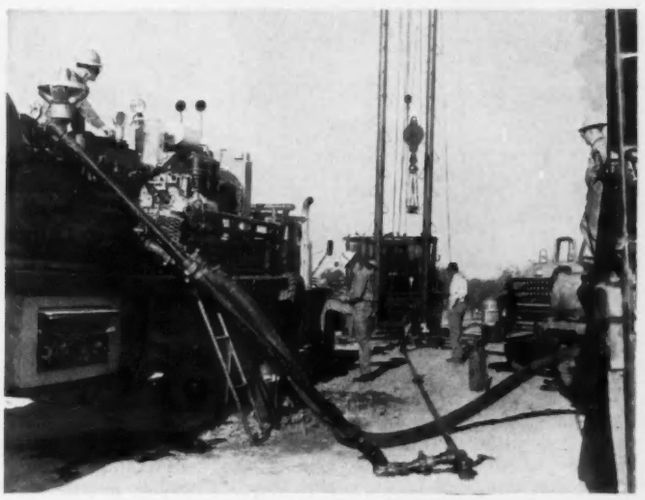
**2. DOWELL REGULAR ACID** is the basis for Dowell acidizing services. It is a 15 per cent by weight inhibited hydrochloric acid solution. One thousand gallons of regular Dowell acid will dissolve 10.8 cubic feet of pure limestone.


Sand Column Clean
Sand Column Plugged
BDA Acid Flowed Through Sand Column Carrying Most Of The Mud With It
Very Little Regular Acid And No Mud Passed Sand Column Due To Plugging Action Of Mud
BREAKDOWN ACID
REGULAR ACID

**3. BREAKDOWN ACID (BDA*)** contains agents that make it especially effective in breaking down and penetrating mud cake, and the formation. It is designed to be used as a spearhead for both fracturing and acidizing treatments.




**5. SILICATE CONTROL ACID** contains an agent designed to control the swelling of certain silicates, clays and bentonites. It is also effective in preventing or breaking oil-in-water emulsions that sometimes occur following an acid treatment.



**6. HEATBLAST** is a new Dowell service designed to remove heavy hydrocarbons and mineral scales near the well bore by increasing the bottom hole temperature of the well. It uses a jel solution carrying magnesium pellets and a specially inhibited acid.

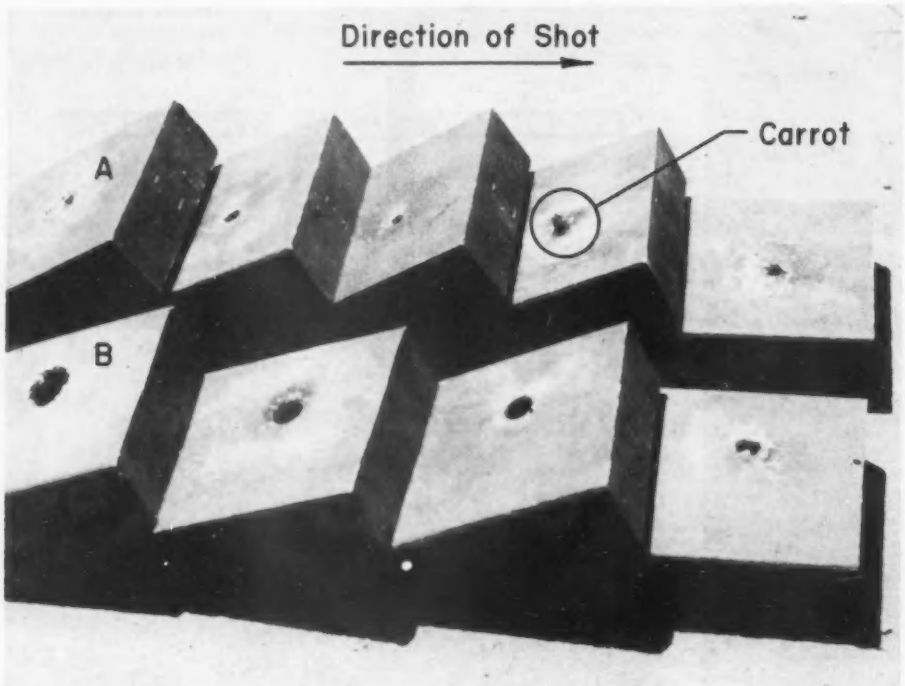
**8. ACID PETROFRAC*** is a Dowell fracturing service that uses an acid-oil emulsion as the fracturing fluid. This fluid, however, is often used on highly soluble formations—without sand —as a retarded acid.

**9. STABILIZED ACID** is designed to prevent the precipitation of iron hydroxide from spent acid. It is widely used to acidize waterflood input wells. It has also proved helpful in producing wells where iron salts are present.

*Dowell Trademark

# What's New in EQUIPMENT and SERVICES

**Drilling - Production - Exploration**




## Jet Charge

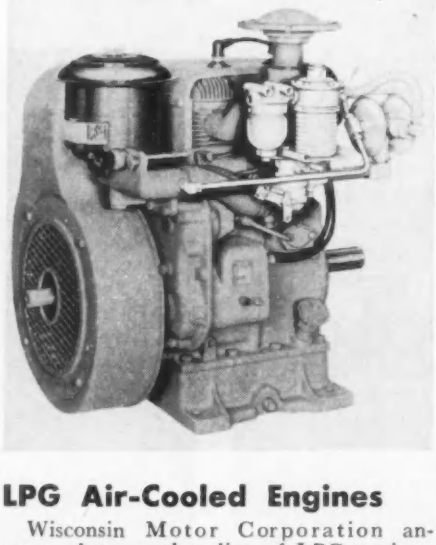
Jet Research Center Incorporated at Arlington, Texas, has developed a new Super-Dyna Jet charge for perforating oil wells that promises to eliminate the old bugaboo of shaped charges, namely the carrot that remained in the perforation.

It has been shown through extensive tests in the flow laboratory that regular jet charges produce carrots less than 50 percent of the time when shot under well conditions. Of the perforations in which carrots were found, only 30 percent had plugs that restricted flow as a result of the carrot. In the remaining 70 percent the carrot was dislodged by backflowing and was laying loose in the clean portion of the perforation and did not restrict flow. To eliminate this small amount of plugging, the Super-Dyna Jet was created.

Physically, the Super-Dyna Jet is very much the same as in the present Dyna-Jet charge which it will replace. The major change is in the liner. A new material and technique is employed in fabricating the liner, resulting in the creation of a carrot-free jet which leaves nothing to plug drainage areas or impede production flow. One of the most important characteristics for the jet stream of a shaped charge is that the liner material must have proper distribution along the jet stream to aid in the creation of a uniform size hole to total depth. This has been accomplished in the new Super-Dyna Jet by using minute spherical copper particles bonded into a metal matrix having a lower melting point than copper. This construction of the liner prevents the slug or carrot from ever forming as is noticed on the test blocks in the attached photograph.

These test blocks of 1-inch thick metal were stacked one on the other and the shaped charge was fired into them. "A" shows the results of the regular Dyna-Jet perforation into steel blocks. Note the carrot blocking the perforated hole in the fourth block. "B" is the result of a super Dyna Jet charge. Note the absence of the carrot in any of the perforated blocks.

For more data, circle **No. E1** on Readers' Service Card, last page this issue.



## LPG Air-Cooled Engines

Wisconsin Motor Corporation announced a complete line of LPG engines. These heavy-duty air-cooled engines have been specially designed for operation on liquefied petroleum fuels (butane, propane or a mixture of both).

They offer the power user such benefits as cleaner operation . . . freedom from gum, lead and carbon deposits; complete fuel evaporation for maximum economy; greatly reduced percentage of carbon monoxide (of special value for in-plant operation); complete combustion of fuel in engine cylinders; definite fuel savings in most areas; no evaporation, spilling or pilferage of fuel; greater operating safety due to the use of a sealed fuel system.

(This item supplements Wisconsin Motor Corp. data on Page 5562 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E2** on Readers' Service Card, last page this issue.

## Unit Covering

A low-cost all steel cover for oil field use is now available from National Steel Products Company. Practical applications include open side covering for packaged compressors, field pump and gathering stations and drilling rig accessories, such as light plants and mud sheds.

The unit is movable and can be put together in two and a half hours by the field crew. The only tools necessary are a screwdriver and a pair of pliers.

For more data, circle **No. E3** on Readers' Service Card, last page this issue.

## Rust Preventative

Improved, long-lasting rust prevention at lower cost is provided by a new industrial coating, Arrust, developed by the Arted Company.

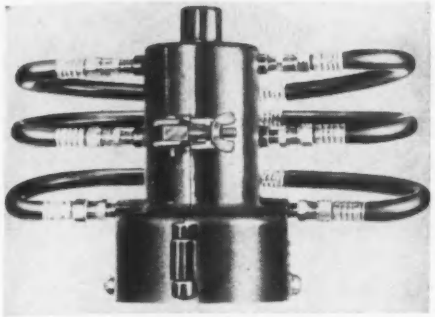
Arrust is a superior, fish oil penetrating coating fortified with a special formula rust inhibitor. Easy to apply, it provides economical, effective rust prevention on all rusted or rustable metals. Arrust can be used directly over firm rusted surfaces without peeling or flaking. It acts as both a prime and finish coat. Except for severely rusted surfaces, only one coat is necessary.

For more data, circle **No. E4** on Readers' Service Card, last page this issue.

## Line Cleaner

Recently placed on the market is a line cleaner called "Jet Away," manufactured and distributed by Bowen Itco, Inc. The manufacturer states it is the only tool for its purpose on the market that operates on air, water or steam. Costly rig mess and line wear are avoided by its use.

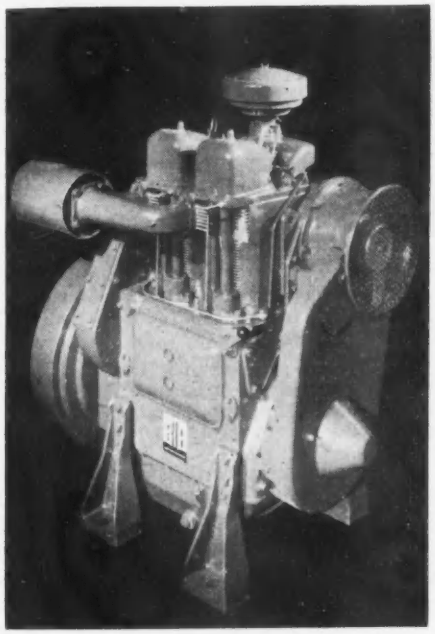
It cleans thoroughly regardless of line speed—increases line life because of frictionless operation. It will clean line and apply rust inhibitor in one operation. Cleaning action is accomplished by the forcing of air, water or steam through three funnel shaped orifices, which produces a thin high velocity jet at each of the cleaning and drying ports. The tool



is economical since it requires no rubbers or packing nut assemblies.

(This item supplements Bowen-Itco data on Pages 773-848 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E5** on Readers' Service Card, last page this issue.



## Air-Cooled Diesel

Ruston & Hornsby Ltd. has designed two new air-cooled engines identified as the "YWA" and the "YDA."

The Class YWA is a four-cycle air-cooled engine of 4-inch bore by 4⅛-inch stroke, manufactured in one and two cylinder sizes providing a power range from 6 to 24½ bhp at an automotive rating over a speed range of 1,000-2,200 rpm.

The Class YDA is a four-cycle air-cooled engine of 4⅜-inch bore by 5-inch stroke, manufactured in two, three, four and six cylinder sizes, providing a power range from 16 to 110 bhp at an automotive rating over a speed range from 1,000 2,200 rpm.

(This item supplements Ruston & Hornsby Ltd. data on Pages 4568-4572 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E6** on Readers' Service Card, last page this issue.

## Wireline Cementing Tool

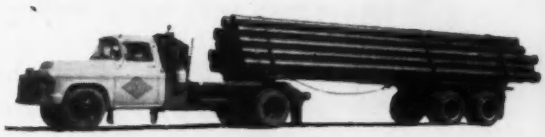
A new wireline cementing tool introduced to field service by Welex, Inc., promises new results in economy and accuracy of squeeze cementing operations for new wells and remedial operations.

With the new tool, more predictable results can be obtained in increasing displacement, preventing cement contamination, eliminating tool movement during the pressurizing cycle, obtaining a satis-


*Congrats and $25 to J. A. LONG, Rua Uruguaiana 118 - 9° andar Rio de Janeiro, Brazil*

Joe Roughneck, heart of the oil and gas industry, likes the convenience and economy of having Lone Star's ultra-modern pipe mill right in the middle of his workshop. Lone Star maintains the largest mill stock of API casing and tubing in the entire oil country. Delivery can be made overnight to 75 per cent of the active areas. Lone Star's recently enlarged plant is, more than ever, Joe Roughneck's solid source of supply.

**Neighbor, wherever you are, specify Lone Star and we both get a good deal.**



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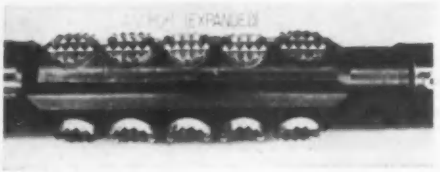


factory packer seal under high pressure, retaining pressure for a prolonged period of time and equalizing pressures following the squeeze.

For more data, circle **No. E7** on Readers' Service Card, last page this issue.

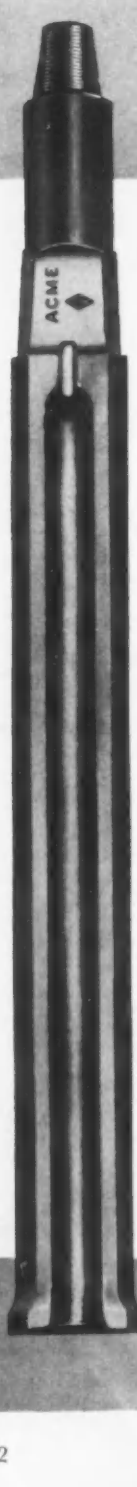
## Rotary Air Compressor

What is believed to be the world's largest portable rotary air compressor manufactured to date is now available from the LeRoi Division, Westinghouse Air Brake Co.

The new LeRoi 1200RD2 is a twin-unit rated at 1,200 cfm of free air compressed to 100 psi. The large-capacity compressor is ideal for providing air power for large tunnel jobs, pile driving, large-hole quarry drilling, four-drill pipe line rigs, multiple drill shaft jumbos, air drilling in the petroleum industry or stand-by plant air.

(This item supplements Westinghouse Air Brake Co., LeRoi Division, data on Pages 3009-3012 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E8** on Readers' Service Card, last page this issue.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CARBON OR ALLOY STEEL

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CARBON STEEL, the standard for years with many drillers.

ALLOY STEEL, deep hardening, stays sharp longer, pioneered by ACME in 1935.

*Sold through dealers everywhere*

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ACME FISHING TOOL CO.
Box 860
PARKERSBURG, WEST VIRGINIA

## Plastic Slurry, Water Gel

Two new materials introduced by Halliburton Oil Well Cementing Co. for the purpose of remedying a major problem in air and gas drilling—controlling the flow of unwanted water—are expected to speed expansion of this type drilling.

One of the products is a plastic slurry, and the other is a polymeric water gel. Their research designations are PC-11 for the slurry and PWG for the gel.

In the picture PC-11 bonds to formation when required squeeze pressure is applied. Formation flow channels are plugged by entry of resinous phase of the slurry. Under stress test the bond at the interface is stronger than the treated section of he formation.

(This item supplements Halliburton Oil Well Cementing Co. data on Pages 2165-2284 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E9** on Readers' Service Card, last page this issue.

## Drift Indicator

A new drift indicator, especially designed for use in slim hole drilling and workovers, has been announced by Garrett Oil Tools, Inc. a division of U. S. Industries, Inc.

Called the Sure-Shot Model A, the new indicator is especially useful where small diameter drill pipe is employed. The tool measures only 1⅜-inch OD; it can be run

inside any 2-inch or larger drill pipe with a bore of 1¾-inch.

The Sure-Shot Model A makes a permanent recording which can be read instantly, and will not fade or be damaged by water, mud or handling.

(This item supplements Garrett Oil Tools, Inc., Division of U. S. Industries, Inc., data, on Pages 1965-2000 of the Composite Catalog, 22nd Edition.)

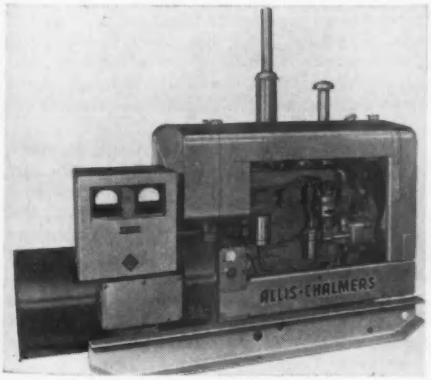
For more data, circle **No. E10** on Readers' Service Card, last page this issue.

## Rubber Sleeve Core Barrel

The rubber sleeve core barrel manufactured by Christensen Diamond Products Co. is a tool designed to provide the analyst with high quality cores. The tool obtains: (1) continuous, undisturbed core in unconsolidated formations, conglomerates or badly fractured rock (2) holds loose core together, thus preventing any wedging which might block inner tube, barrel is allowed to fully advance (3) protects core from damage caused by moving fluid and (4) packages unconsolidated core so that it can be easily handled and transported with a minimum amount of disturbance.

(This item supplements Christensen Diamond Products Co. data on Pages 1321-1344 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E11** on Readers' Service Card, last page this issue.



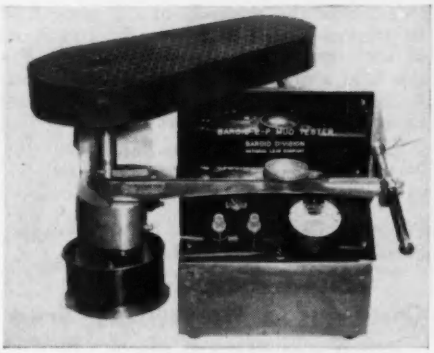

## Generator Set

Addition to its line of power producing equipment of a portable lightweight generator set developing 35,000 watts (35 kw) is announced by the Engine-Material Handling division, Allis-Chalmers Manufacturing Co.

The unit is complete as a package, with all controls and accessories needed for immediate use. Because it is completely weatherized, it can be used either outdoor or indoors. The switchboard and instrument panel are protected against weather, dirt and tampering by a completely enclosed cabinet with a glass door that can be locked.

(This item supplements Allis-Chalmers data on Pages 169 of the Composite Catalog, 22nd Edition.)

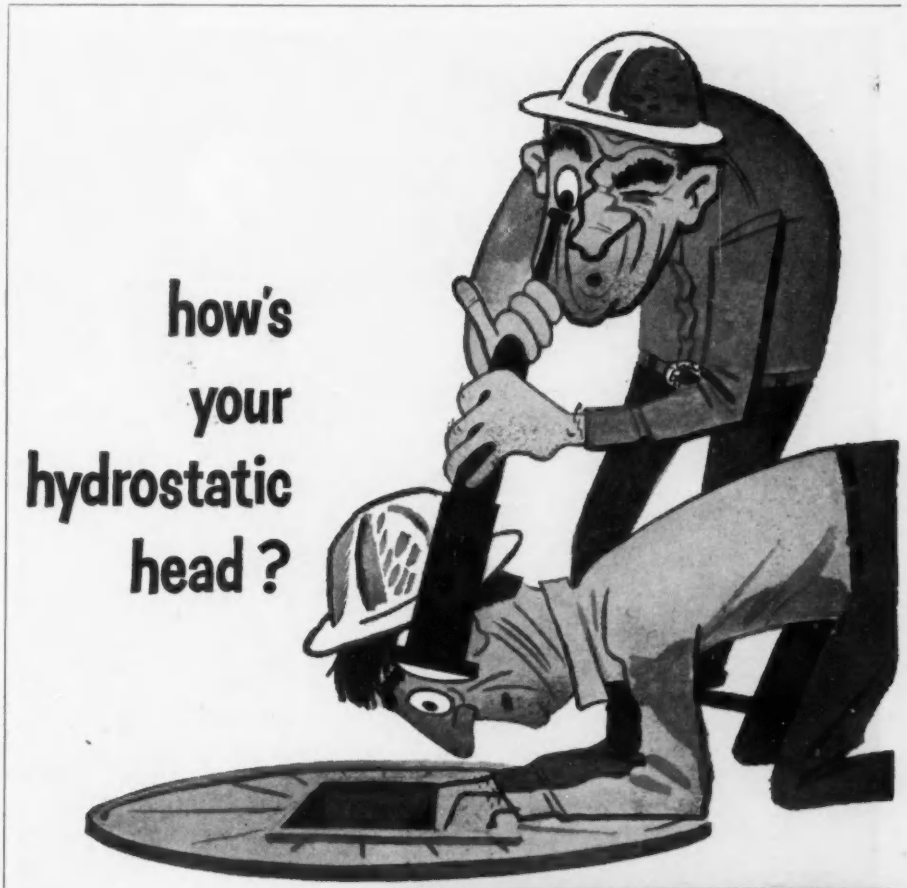
For more data, circle **No. E12** on Readers' Service Card, last page this issue.



## Mud Tester

Baroid's portable E P mud tester is a new item of mud testing equipment developed by Baroid as a portable field instrument for on-location determination of the extreme pressure lubricating properties of a drilling fluid.

The Baroid E P mud tester gives a


SEE WHAT'S HAPPENING DOWN THE HOLE WITH **Pit-O-Graf**

(Records mud pit level)

From the Pit-O-Graf chart you can calculate effectively any loss in hydrostatic head due to gas or salt water incursion. The continuous mud pit level chart warns of blowouts or threatened blowouts and loss of circulation.

WARREN AUTOMATIC TOOL CO. — WATCO — HOUSTON

**WARREN AUTOMATIC TOOL CO.**

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HEmlock 6-2265 EMerson 9-9862 FOrest 6-1441

measure of the property of a drilling fluid to prevent bearing seizure under conditions of high load. These measurements enable the field man to determine the initial and maintenance quantities of E P Mudlube to add to the drilling fluid.

(This item supplements Baroid Division, National Lead Co., data on Pages 642-645 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E13** on Readers' Service Card, last page this issue.

## Quadruple Christmas Tree

Recent completion of the oil industry's first four parallel string quadruple zone completion by the CATC offshore group in the Gulf of Mexico utilized a new type of christmas tree made by Cameron Iron Works, Inc., of Houston.

For CATC's quadruple tree, Cameron designed a closed pressure system for complete control at all times using three solid forged steel blocks—one for the tubing head spool, one for the four master valves and one for the four tree valves.

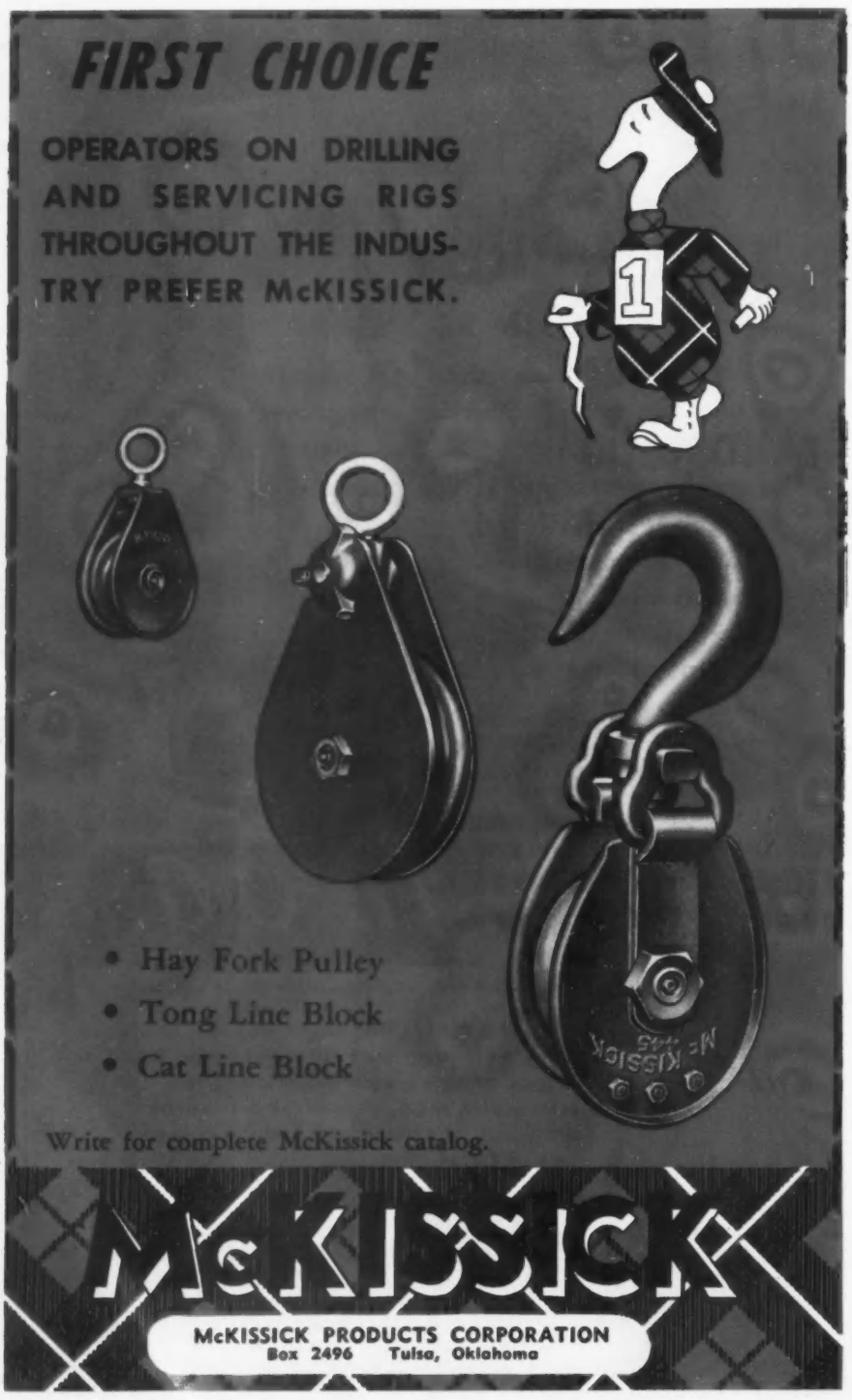
The tubing head spool is designed to receive, lock down and seal four segmented tubing hangers. During the time drilling controls were removed and the tree installed, each of the locked down, sealed hangers had a 30,000 psi rated Cameron back pressure valve installed in the hanger annulus. These were removed after the complete tree had been installed and tested.

The solid forged steel blocks of four master valves and four tree valves are the new design Cameron Gate Valves, Type F, with stainless steel seats which rotate a fraction each time the gates are opened

and closed to give longer and more even wear over the entire seating surface.

(This item supplements Cameron Iron Works, Inc., data on Pages 1141-1200-H of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E14** on Readers' Service Card, last page this issue.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Write for complete McKissick catalog.
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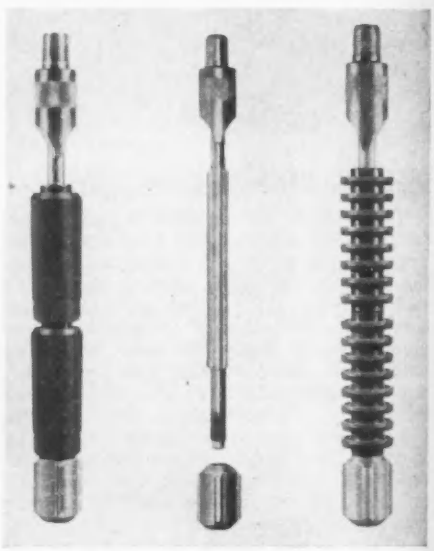


## New Type Swab

A new line of tubing swabs with interchangeable rubbers is announced by Byron Jackson Tools, Inc., a subsidiary of Borg-Warner Corporation.

The new swab line features both cup type rubbers and the multi-disc type. A pair of either kind fits onto the streamlined two-piece body. The rubbers are designed for extreme flexibility of operation; they automatically adjust themselves to different loads.

To minimize friction wear and to speed the drop to the bottom, BJ swabs are designed to allow an annular clearance going down. When the swab is pulled, this clearance closes up and gives a positive seal that allows it to pull the heaviest loads.

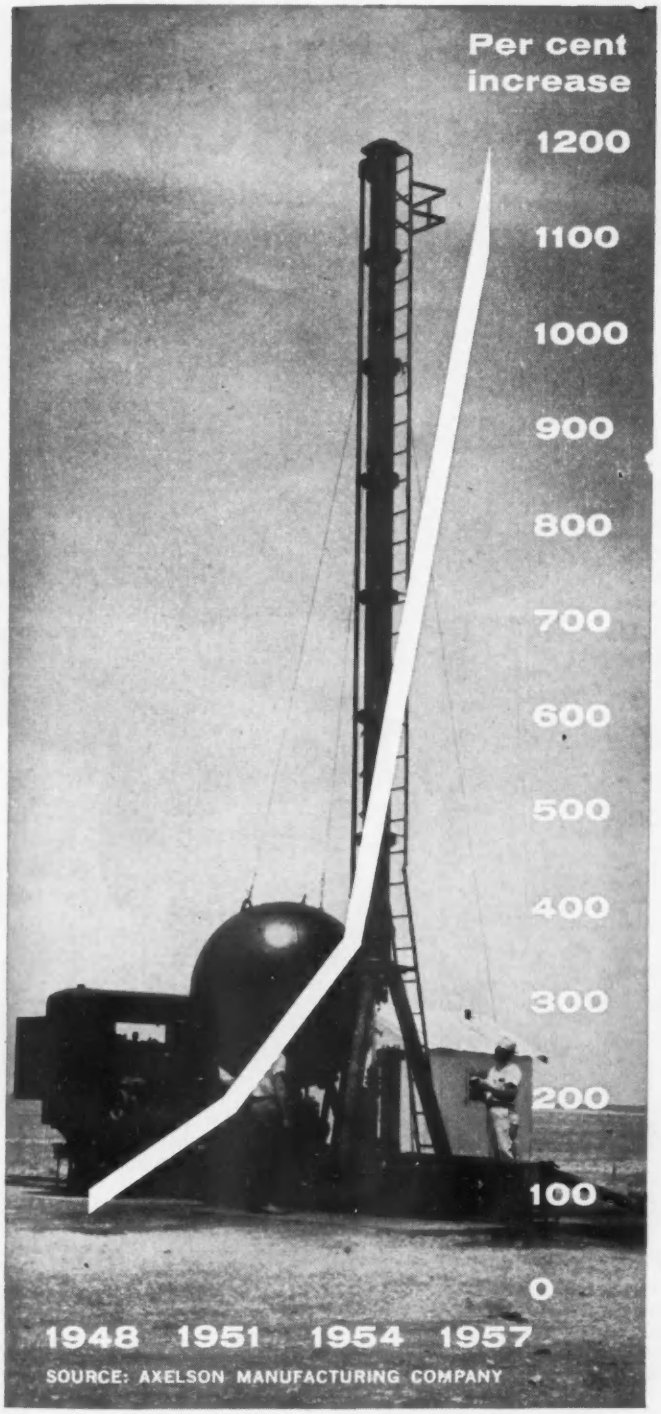
(This item supplements Byron Jackson Tools, Inc., a subsidiary of Borg-Warner Corp., data on Pages 973-1108 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E15** on Readers' Service Card, last page this issue.

## Top Entry Check Valve

A new top entry double union check valve for oil process lines, first to be insulated against electrolytic action, has been designed by Clayton Mark & Company.

The valve features a precision manu-

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## Axelson Hydrax Use Shows 10-year Record Growth

Here's why:

- **Vastly improved volumetric efficiency**
- **Sucker rod life extended as much as eight times**
- **Rod stresses safely increased as much as 30%**
- **Gas lock eliminated by high compression ratios**
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- **Simple to install.**

**HYDRAX units are backed by a factory-trained service organization.**

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*Since 1898 products designed to give oil a lift*

There is no economical substitute for quality.

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AXELSON PRODUCTS ARE DISTRIBUTED EVERYWHERE

CALIFORNIA: Offices and warehouse in Los Angeles and Long Beach
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# DON'T WELD ON CASING!

**B and W**

## FRICTION-LOCK CLAMPS

**give you these distinct advantages in mounting scratchers and centralizers:**

**LOWER COST** . . . Friction-Lock Clamps cost less than welding when ordered with B and W Scratchers and Centralizers.

**WITHSTANDS GREATER THRUST** . . . exhaustive laboratory tests prove Friction-Lock Clamps withstand resistance to vertical movement far in excess of average field welding.

**ELIMINATES WELDING DAMAGE** . . . average field welding may damage casing from undercutting, hard spots and electrolytic corrosion . . . Friction-Lock Clamps cannot damage casing.

**ONLY FULL GRIPPING DEVICE** . . . only the Friction-Lock Clamp grips uniformly around the complete periphery of the casing . . . other holding devices grip over relatively small areas.

**EASIER INSTALLATION** . . . B and W Friction-Lock Clamps may be installed in seconds with a simple hex wrench.

**ANOTHER FIRST BY THE FIRST NAME IN PRIMARY CEMENTING TOOLS**

***OTHER B and W PRODUCTS:***

Multi-Flex Scratchers • Nu-Coil Scratchers • Rotating Scratchers, Multi-Flex and Nu-Coil Types • Automatic Stop Collars • Stabilizers • Rotator Collars • Liner Centralizers • Latch-On and Solid Type Centralizers • Thread-Lock Cages • Thread-Lock Cement.

**B and W Inc.**

*Well Completion Specialists*

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PHONE WAlnut 3-6603

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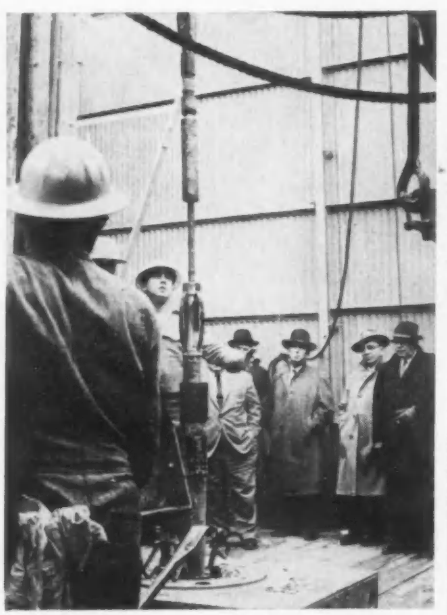
factured bronze clapper, engineered to provide quiet operation and effective closure when the flow pressure drops. Full opening passage is provided for line cleaning and removal of paraffin and other deposits.

(This item supplements Clayton Mark & Co. data on Pages 3186-3187 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E16** on Readers' Service Card, last page this issue.



## Wire Line Setting Tool

The job of setting bridge plugs and squeeze and production packers can now be done cheaper using the rig sand line with the new hydraulic wire line setting tool developed by Halliburton Oil Well Cementing Company.

The new tool may be used in wells with or without fluid; the necessary hydraulic fluid for operations is carried in the tool. Only a light duty rig sand line is required to operate the tool, which reduces the usual special setup and footage charges. Another saving comes from rig time lost when conventional setting tools use tubing for the setting operation.

(This item supplements Halliburton Oil Well Cementing Co. data on Pages 2165-2284 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E17** on Readers' Service Card, last page this issue.

## Rod Packaging

Simplicity and compactness are the two principal requirements of packaging in assuring delivery of rods in perfect condition. National Supply Company engineers have presented an answer to this problem.


# We've gone all out on DARCOVAS

**. . . The Original Composition Valve Cups**

**. . . to give you unmatched well pumping economy and efficiency!**

Darcovas are the truly performance-engineered valve cups, seating cups and rings. Designed to do more than "fill a barrel". Designed to prolong pumping efficiency and reduce down-time and maintenance! Features include 100% nylon composition, range of textures for every condition, and complete range of precision sizes for every make or size of pump.

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And since there's no substitute be sure to specify DARCOVA

**DARLING VALVE & MANUFACTURING COMPANY**

DARCOVA ®

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# HERE'S A "GREASE-CUTTER" THAT CUTS RIG-CLEANING COSTS TOO!

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RIG WASHING COMPOUND

For cleaning everything from superstructure to substructure, RW's speed and thoroughness have made this remarkable product a favorite among oil-rig operators who want to keep cleaning costs to a minimum.

RW was developed by Procter & Gamble to cut oil and grease quickly. Yet unlike many other cleaning agents, it's not hard on paint or workers' hands. RW compound is easy and economical to use . . . will produce suds in hard or soft water . . . hot as well as cold water.

If you're looking to reduce your rig-cleaning costs, try RW compound and it'll become your favorite too!

*Procter & Gamble*

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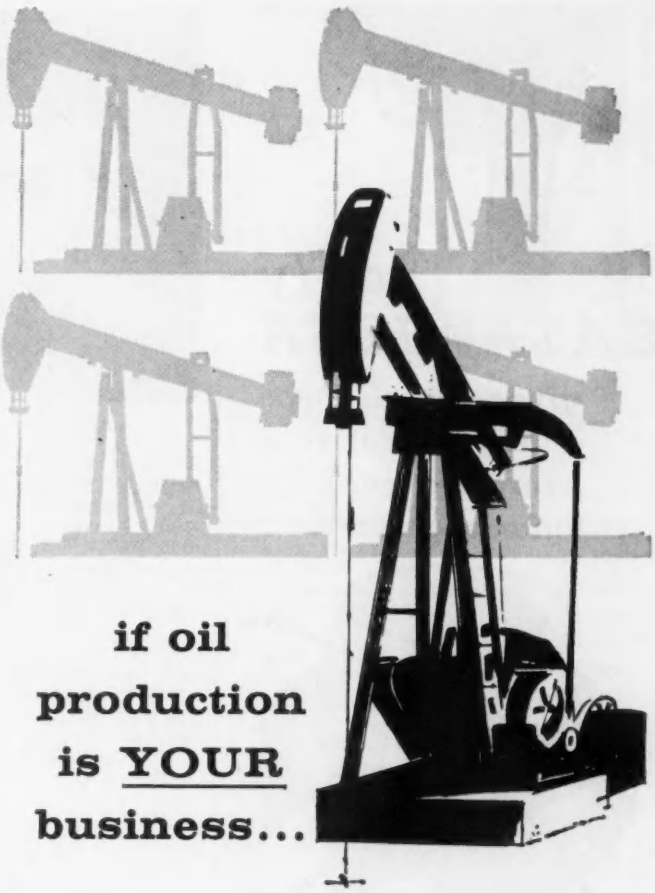

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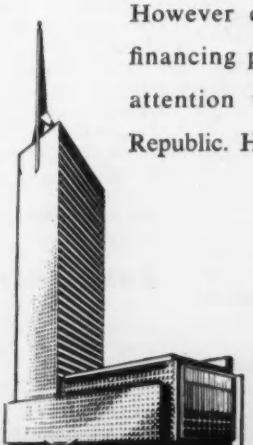
Here, at Republic National Bank, the combined experience and proved performance of the South's largest and most active Oil Department are concentrated on better service to the oil producer. However complex your production financing problem, you'll get expert attention to your requirements at Republic. How may we help you?



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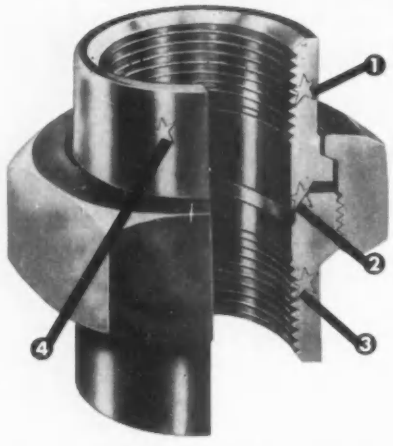
MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

*only*
**CATAWISSA**
*gives you all these features for your forged steel pipe union requirements*




1. **Uniform walls** for even expansion and contraction under temperature changes. They follow the pipe!

2. **Catawissa Ball-to-Angle Seats** give you a "Perfect Seal" regardless of pipe alignment!

3. **More than adequate** wall thicknesses give you Catawissa's 3-to-1 Safety Factor (3000-lb. service, 9000-lb. test; 6000-lb. service, 18000-lb. test)!

4. **Round, straight barrels** for fast wrenching. No uneven or tapered surfaces to cause wrench slips or wrench locking!

Catawissa Perfect Seal Pipe Unions are made by Union Specialists from 80,000 lb. tensile strength steel (ASTM Spec. A-105-55T, Grade II). Steel forgings from our own forging mill are closely checked for imperfections . . . and finishing on modern, automatic machines with close inspection during and after production give you pipe unions second to none!

Write for Catalog 58 showing the complete Catawissa line of Perfect Seal Products.

*for complete, guaranteed satisfaction*

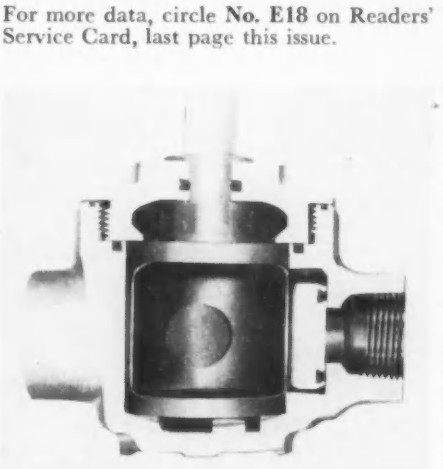
*. . . always specify*
**CATAWISSA**

**CATAWISSA VALVE & FITTINGS CO.**
**CATAWISSA • PENNSYLVANIA**

Only two principal elements were required in making a package containing a maximum of 40, 60 or 80 rods (depending on diameter) which may weigh up to approximately two tons. These are 28½-inch oxiline treated seasoned wood separator blocks (1⅝-inch by 1⅝-inch) with 15 or 20 grooves across both of the long sides. Steel straps encircle the package.

(This item supplements The National Supply Co. data on Pages 3641-3752 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E18** on Readers' Service Card, last page this issue.



## Dual-Purpose Valve

A new and unique multi-purpose valve developed by Vic and Norman Haenky was released for sale by the Frank Wheatley Supply. Called the "Plugaroo," the new unit operates as botn a plug and check valve.

The Plugaroo is a non-lubricated plug valve which opens and closes with a quarter turn. In open position the Plugaroo performs as a synthetic seal check valve. The clapper, hinged vertically on a 20 degree angle, seals by its own weight.

For more data, circle **No. E19** on Readers' Service Card, last page this issue.

## Gate Valve

A new leakproof gate valve which incorporates Teflon seals in the wedge has been placed on the market by Hamer Valves, Inc.

Trade-named the Wedge-Seal by the manufacturer, this new valve marks a radical departure from conventional gate valves. As the wedge is lowered in the Hamer valve to a precision metal-to-metal fit against the seats, the Teflon seals on either side of the wedge compress against the seats to form a double sealing action. This double sealing action, states Hamer Valves, enables the New Wedge-Seal valve to provide a positive shutoff both upstream

**use**
# EXTRA STRENGTH
**for dual completion oil wells**

These couplings have thinner walls and a special O.D. chamfer to accommodate two lines in one casing. Due to the thinner wall we recommend:

**N-80 COUPLING FOR USE WITH J-55 TUBING**
Identified by all-over red for N-80 and green stripe for use with J-55 tubing.

**P-105 COUPLING FOR USE WITH N-80 TUBING**
Identified by all-over white for P-105 and red stripe for use with N-80 tubing.

PACKED 25 PER CARTON

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**COLUMBUS, OHIO**

COUPLINGS — NIPPLES — UNIONS —
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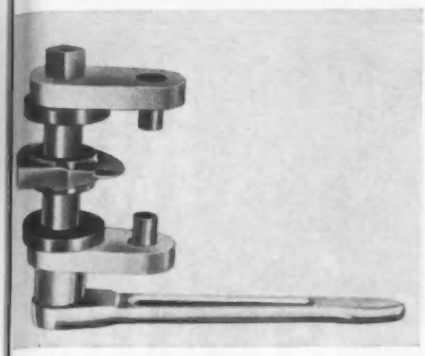
nd downstream, eliminating the need for double block and bleed in piping installations.

(This item supplements Hamer Valves, nc., data on Pages 2290-2291 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E20** on Readers' Service Card, last page this issue.



## Flange Spreader

An entirely new and different tool for spreading flanged pipe connections—to insert gaskets, orifices, etc.—is now being manufactured and marketed. This tool has been named "Safety Boy" because, by its use, flanges can be spread safer, faster and more economically.

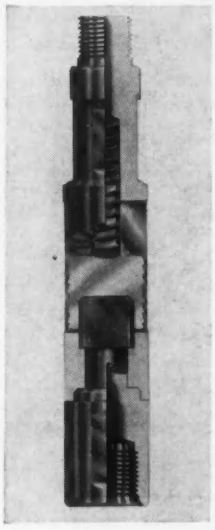
A patented feature of this new tool is a circular cam wedge. This feature, plus the use of a ratchet handle, provides pipefitters with a lightweight, handy-to-carry tool that will spread a flange in a matter of seconds.

Safety Boy is manufactured and marketed by the Wm. L. Riggs Company.

For more data, circle **No. E21** on Readers' Service Card, last page this issue.

## New Wireline Tool

The Bowen Itco "Quick Lok," is a tool for downhole connection. It is light, simple to operate and strong; adapted to gas lift servicing, pulling chokes and wire line fishing operations; and allows tools to be changed without removing completely from the lubricator. When the Quick Lok is employed, changing tools requires only lifting the lubricator, exposing the top connection on the bottom tool, releasing the Quick Lok, and making up the next tool.



(This item supplements Bowen-Itco data on Pages 773-848 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E22** on Readers' Service Card, last page this issue.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KINLEY TUBING PERFORATOR

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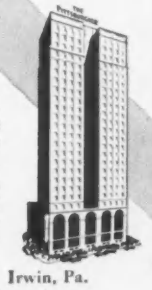

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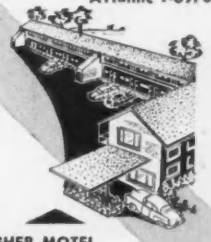

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Opposite Greater Pittsburgh Airport on beautiful Airport Parkway West. 56 luxurious, air-conditioned rooms with tile bath, TV, private phone. Courtesy car to and from airport.

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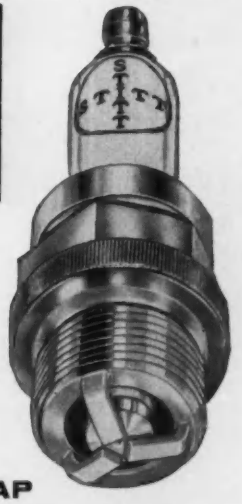


*new triple ignitors*

. . . HOLD GAP SETTING LONGER

Field Tests PROVE that STITT oil-field-engineered New Triple Ignitors hold gap settings longer — magneto points last longer — cut "down time," to give long-life performance. Stitts save real dollars per engine per year. To get better service from your engines—regardless of make—send for FREE Pocket Catalog and Application Chart that specifies the RIGHT plug for all your engines, and Field Test Reports.

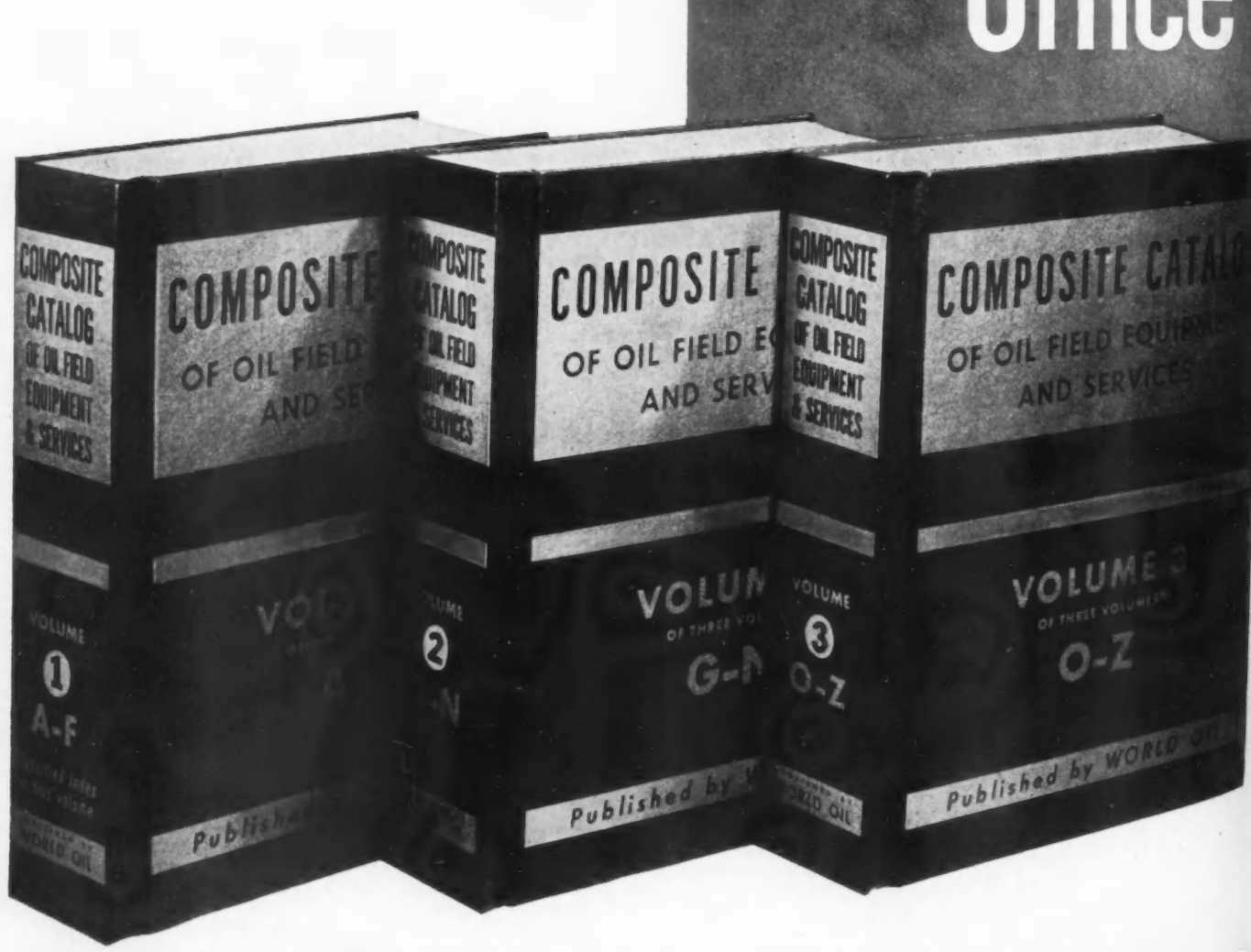
582

STITT IGNITION CO.
Dept. WO Columbus, Ohio

STITT MAKES HEAVY DUTY INDUSTRIAL SPARK PLUGS

# At the Rig Or in the Office

- More than 500 Individual Company Catalogs
- Over 5,000 Pages of Equipment Information
- Indexed and Cross-Referenced
- Fast, Accurate, Current Reference




## COMPOSITE CATALOG OF OIL FIELD EQUIPMENT AND SERVICES

Published by World Oil, P.O. Box 2608, Houston

# New Literature

**For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Readers' Service postcards just inside the back cover and facing the Advertisers Index. Simply circle code numbers of items desired—sign and mail card. Requests are transmitted to the manufacturer as soon as received by us for mailing of desired information directly to you.**

## Drilling Muds

"Still Better Drilling Muds with Tylose" is the title of a new 20-page brochure available from Kalle & Co. Intended as a handbook of technical data on drilling muds, the new literature presents detailed information and recommendations on the application of the company's CMC—carboxymethylcellulose—additives for effective and efficient drilling mud control.

To get a copy, circle **No. E23** on Readers' Service Card, last page this issue.

## Pump Pamphlet

A new eight-page brochure on two-zone pumps is now available from the Axelson Manufacturing Company, a division of U. S. Industries, Inc. The brochure includes the three basic two-zone pump configurations, consisting of two-packer single string, one-packer double string, and one-packer triple string.

To get a copy, circle **No. E24** on Readers' Service Card, last page this issue.

## Wire Rope Lube Manual

Reducing wire rope cost by lengthening its life through proper lubrication is the subject of a new booklet issued by Union Wire Rope Corporation. The 12-page pocket size book briefly summarizes why the construction of a wire rope necessitates lubrication, the lubricants recommended for different types of wire rope and operating conditions and how to apply lubrication in the field.

To get a copy, circle **No. E25** on Readers' Service Card, last page this issue.

## Well Logging Brochure

Schlumberger Well Surveying Corporation has published a new and comprehensive review of its well logging methods, Schlumberger Document No. 8, "Introduction to Schlumberger Well Logging." The book is intended as a text for those persons who wish to make a study of logging methods.

To get a copy, circle **No. E26** on Readers' Service Card, last page this issue.

## Rotary Rock Bit Booklet

Rotary Rock Bit Catalog for 1958-59 has been issued by Varel Manufacturing Company. Included in the catalog are descriptions of all rock bit types and the formations they are designed to drill.

To get a copy, circle **No. E27** on Readers' Service Card, last page this issue.

## Cementing Catalog

A new catalog describing all-metal shoes and collars and other cementing equipment designed and manufactured by Rector Well Equipment Co., Inc., is ready for distribution. Liberally illustrated with photographs and cutaway drawings, the catalog includes operating and performance data on the Rector Type "A" cementing shoes and collars, the Type "C" fill shoe and collar that permits operator to switch from filling to circulating and back to filling again, the Type "T" two-plug stage cementer, the Type "E" cementing head, and other special equipment.

To get a copy, circle **No. E28** on Readers' Service Card, last page this issue.

## DAU Operating Brochure

A new catalog published by the Parkersburg Rig & Reel Company gives complete operating details on the Dynamic Adsorption Unit (DAU) designed and manufactured by that company. Included are graphic diagrams showing typical applications of DAU units Type I Weldrier for dehydration and for the DAU Type II Welsorber for dehydration and hydrocarbon recovery.

To get a copy, circle **No. E29** on Readers' Service Card, last page this issue.

## Wire Rope Splicing Data

A highly illustrated 38-page handbook on splicing techniques is being offered by the Union Wire Rope Corporation. This handbook covers various eye splicing methods, endless splices, preformed and Lang Lay wire rope splicing and the Chicago technique.

To get a copy, circle **No. E30** on Readers' Service Card, last page this issue.

## Helical Gear Drive Info

Folder 2651-A, a new six-page supplement to Link-Belt Book 2651, contains complete data on horsepower ratings, dimensions, mounting information and a resume of construction principles applying to the completely new quadruple reduction speed reducers.

To get a copy, circle **No. E31** on Readers' Service Card, last page this issue.

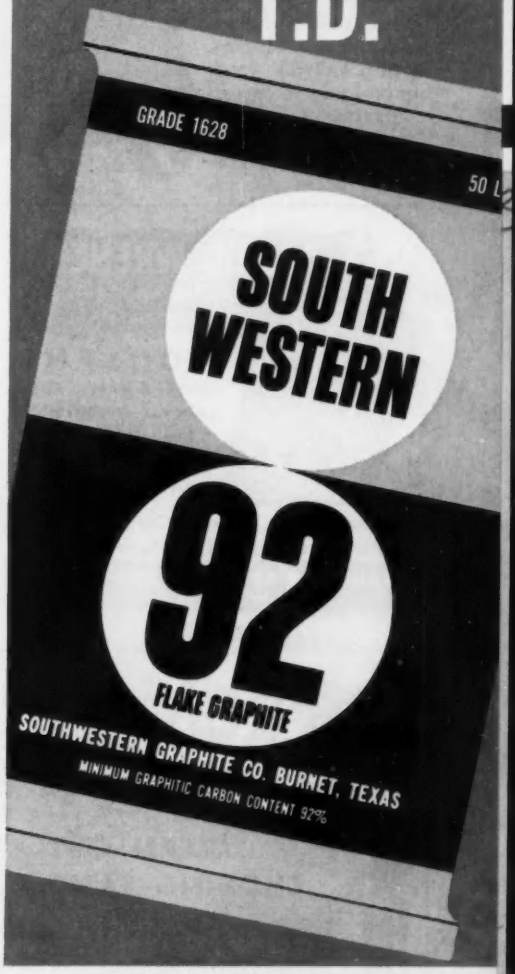
## Sucker Rod Booklet

Sucker rod production from the initial selection of steel through shipping is described and pictorially illustrated in a new 24-page Axelson Sucker rod brochure.

Special emphasis has been given to steel production, mill production, manufacturing and quality control aspects of sucker rod coupling and polish rod production. Engineering data is also included.

To get a copy, circle **No. E32** on Readers' Service Card, last page this issue.


SLICKEST WAY TO T.D.




USED AND RECOMMENDED

. . . *especially* under conditions where TORQUE, DRAG, OR THE HAZARD OF STICKING DRILL-STEM AND CASING are encountered.

FIVE YEARS OF FIELD EXPERIENCE

have proved the effectiveness and versatility of

92 SOUTHWESTERN FLAKE GRAPHITE

Available through your mud dealer.

SOUTHWESTERN GRAPHITE CO.

BURNET, TEXAS

*for* **leakproof, pressure-tight connections**

*use* **TiteSeal®**

**SEALING COMPOUNDS**

Heat and vibration-proof, non-solvent, will not shrink, crack or crumble. Makes all assemblies leak-proof and pressure-tight. Prevents rust, corrosion, joint seizure.

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**LIQUID WRENCH®**

The super-penetrating rust solvent

**LOOSENS**

rusted bolts, nuts, screws, 'frozen' parts

Liquid Wrench works *fast*...yet is absolutely safe for all metals and alloys.

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*At Industrial, Automotive, Hardware, Plumbing Jobbers*

SOLDER SEAL

**RADIATOR SPECIALTY CO.**

Charlotte, North Carolina

**INCREASE PRODUCTION**

**CLEAN OUT CHOKING SAND**

Excessive sand and sediment holds back your oil. For fast, easy clean out with fewer round trips and less down-time, use world famous Miller Sand Pumps.

**SAND PUMP SIZES**

O.D.—2½, 3, 3½, 4¼, 5, 5½, 7 in.
Lengths—20, 25, 30 ft.

**Composite Catalog, Page 3419**

*Write for descriptive price list*

**MILLER SAND PUMPS**

**Miller Sand Pump Co.**

General Offices, Box 4516
Oklahoma City 9, Okla

**EXPORT OFFICES**
30 Rockefeller Plaza
NEW YORK CITY 20, N. Y.


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